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The United States Air Force Summer Research Program (USAF-SRP) is designed to introduce university, college, and technical institute faculty members, graduate students, and high school students to Air Force research. This is accomplished by the faculty members (Summer Faculty Research Program (SFRP)), graduate students (Graduate Student Research Program (GSRP)), and high school students (High School Apprenticeship Program (HSAP)) being selected on a nationally advertised competitive basis during the summer intersession period to perform research at Air Force Research Laboratory (AFRL) Technical Directorates, Air Force Air Logistics Centers (ALC), and other AF Laboratories. The management volume consists of a program overview, program management statistics, a listing of the participants, and an abstract for each participants summer research.

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UNITED STATES AIR FORCE

SUMMER RESEARCH PROGRAM -- 1996

SUMMER RESEARCH PROGRAM FINAL REPORTS

VOLUME 1

RESEARCH & DEVELOPMENT LABORATORIES

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Washington, D.C.

December 1996

PREFACE

Reports in this volume are numbered consecutively beginning with number 1. Each report is paginated with the report number followed by consecutive page numbers, e.g., 1-1, 1-2, 1-3; 2-1, 2-2, 2-3.

This document is one of a set of 16 volumes describing the 1996 AFOSR Summer Research Program. The following volumes comprise the set:

VOLUME	TITLE
1	Program Management Report
	Summer Faculty Research Program (SFRP) Reports
2A & 2B	Armstrong Laboratory
3A & 3B	Phillips Laboratory
4	Rome Laboratory
5A, 5B & 5C	Wright Laboratory
6	Arnold Engineering Development Center, Wilford Hall Medical Center and Air Logistics Centers
	Graduate Student Research Program (GSRP) Reports
7A & 7B	Armstrong Laboratory
8	Phillips Laboratory
9	Rome Laboratory
10A & 10B	Wright Laboratory
11	Arnold Engineering Development Center, United States Air Force Academy, Wilford Hall Medical Center, and Wright Patterson Medical Center
	High School Apprenticeship Program (HSAP) Reports
12A & 12B	Armstrong Laboratory
13	Phillips Laboratory
14	Rome Laboratory
15A&15B	Wright Laboratory
16	Arnold Engineering Development Center

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INTRODUCTION

The Summer Research Program (SRP), sponsored by the Air Force Office of Scientific Research (AFOSR), offers paid opportunities for university faculty, graduate students, and high school students to conduct research in U.S. Air Force research laboratories nationwide during the summer.

Introduced by AFOSR in 1978, this innovative program is based on the concept of teaming academic researchers with Air Force scientists in the same disciplines using laboratory facilities and equipment not often available at associates' institutions.

The Summer Faculty Research Program (SFRP) is open annually to approximately 150 faculty members with at least two years of teaching and/or research experience in accredited U.S. colleges, universities, or technical institutions. SFRP associates must be either U.S. citizens or permanent residents.

The Graduate Student Research Program (GSRP) is open annually to approximately 100 graduate students holding a bachelor's or a master's degree; GSRP associates must be U.S. citizens enrolled full time at an accredited institution.

The High School Apprentice Program (HSAP) annually selects about 125 high school students located within a twenty mile commuting distance of participating Air Force laboratories.

AFOSR also offers its research associates an opportunity, under the Summer Research Extension Program (SREP), to continue their AFOSR-sponsored research at their home institutions through the award of research grants. In 1994 the maximum amount of each grant was increased from $20,000 to $25,000, and the number of AFOSR-sponsored grants decreased from 75 to 60. A separate annual report is compiled on the SREP.

The numbers of projected summer research participants in each of the three categories and SREP "grants" are usually increased through direct sponsorship by participating laboratories.

AFOSR's SRP has well served its objectives of building critical links between Air Force research laboratories and the academic community, opening avenues of communications and forging new research relationships between Air Force and academic technical experts in areas of national interest, and strengthening the nation's efforts to sustain careers in science and engineering. The success of the SRP can be gauged from its growth from inception (see Table 1) and from the favorable responses the 1996 participants expressed in end-of-tour SRP evaluations (Appendix B).

AFOSR contracts for administration of the SRP by civilian contractors. The contract was first awarded to Research & Development Laboratories (RDL) in September 1990. After completion of the 1990 contract, RDL (in 1993) won the recompetition for the basic year and four 1-year options.

2. PARTICIPATION IN THE SUMMER RESEARCH PROGRAM

The SRP began with faculty associates in 1979; graduate students were added in 1982 and high school students in 1986. The following table shows the number of associates in the program each year.

YEAR	SRP Participation, by Year			TOTAL
	SFRP	GSRP	HSAP	
1979	70			70
1980	87			87
1981	87			87
1982	91	17		108
1983	101	53		154
1984	152	84		236
1985	154	92		246
1986	158	100	42	300
1987	159	101	73	333
1988	153	107	101	361
1989	168	102	103	373
1990	165	121	132	418
1991	170	142	132	444
1992	185	121	159	464
1993	187	117	136	440
1994	192	117	133	442
1995	190	115	137	442
1996	188	109	138	435

Beginning in 1993, due to budget cuts, some of the laboratories weren't able to afford to fund as many associates as in previous years. Since then, the number of funded positions has remained fairly constant at a slightly lower level.

3. RECRUITING AND SELECTION

The SRP is conducted on a nationally advertised and competitive-selection basis. The advertising for faculty and graduate students consisted primarily of the mailing of 8,000 52-page SRP brochures to chairpersons of departments relevant to AFOSR research and to administrators of grants in accredited universities, colleges, and technical institutions. Historically Black Colleges and Universities (HBCUs) and Minority Institutions (MIs) were included. Brochures also went to all participating USAF laboratories, the previous year's participants, and numerous individual requesters (over 1000 annually).

RDL placed advertisements in the following publications: *Black Issues in Higher Education, Winds of Change,* and *IEEE Spectrum.* Because no participants list either *Physics Today* or *Chemical & Engineering News* as being their source of learning about the program for the past several years, advertisements in these magazines were dropped, and the funds were used to cover increases in brochure printing costs.

High school applicants can participate only in laboratories located no more than 20 miles from their residence. Tailored brochures on the HSAP were sent to the head counselors of 180 high schools in the vicinity of participating laboratories, with instructions for publicizing the program in their schools. High school students selected to serve at Wright Laboratory's Armament Directorate (Eglin Air Force Base, Florida) serve eleven weeks as opposed to the eight weeks normally worked by high school students at all other participating laboratories.

Each SFRP or GSRP applicant is given a first, second, and third choice of laboratory. High school students who have more than one laboratory or directorate near their homes are also given first, second, and third choices.

Laboratories make their selections and prioritize their nominees. AFOSR then determines the number to be funded at each laboratory and approves laboratories' selections.

Subsequently, laboratories use their own funds to sponsor additional candidates. Some selectees do not accept the appointment, so alternate candidates are chosen. This multi-step selection procedure results in some candidates being notified of their acceptance after scheduled deadlines. The total applicants and participants for 1996 are shown in this table.

1996 Applicants and Participants			
PARTICIPANT CATEGORY	TOTAL APPLICANTS	SELECTEES	DECLINING SELECTEES
SFRP	572	188	39
(HBCU/MI)	(119)	(27)	(5)
GSRP	235	109	7
(HBCU/MI)	(18)	(7)	(1)
HSAP	474	138	8
TOTAL	1281	435	54

4. SITE VISITS

During June and July of 1996, representatives of both AFOSR/NI and RDL visited each participating laboratory to provide briefings, answer questions, and resolve problems for both laboratory personnel and participants. The objective was to ensure that the SRP would be as constructive as possible for all participants. Both SRP participants and RDL representatives found these visits beneficial. At many of the laboratories, this was the only opportunity for all participants to meet at one time to share their experiences and exchange ideas.

5. HISTORICALLY BLACK COLLEGES AND UNIVERSITIES AND MINORITY INSTITUTIONS (HBCU/MIs)

Before 1993, an RDL program representative visited from seven to ten different HBCU/MIs annually to promote interest in the SRP among the faculty and graduate students. These efforts were marginally effective, yielding a doubling of HBCI/MI applicants. In an effort to achieve AFOSR's goal of 10% of all applicants and selectees being HBCU/MI qualified, the RDL team decided to try other avenues of approach to increase the number of qualified applicants. Through the combined efforts of the AFOSR Program Office at Bolling AFB and RDL, two very active minority groups were found, HACU (Hispanic American Colleges and Universities) and AISES (American Indian Science and Engineering Society). RDL is in communication with representatives of each of these organizations on a monthly basis to keep up with the their activities and special events. Both organizations have widely-distributed magazines/quarterlies in which RDL placed ads.

Since 1994 the number of both SFRP and GSRP HBCU/MI applicants and participants has increased ten-fold, from about two dozen SFRP applicants and a half dozen selectees to over 100 applicants and two dozen selectees, and a half-dozen GSRP applicants and two or three selectees to 18 applicants and 7 or 8 selectees. Since 1993, the SFRP had a two-fold applicant increase and a two-fold selectee increase. Since 1993, the GSRP had a three-fold applicant increase and a three to four-fold increase in selectees.

In addition to RDL's special recruiting efforts, AFOSR attempts each year to obtain additional funding or use leftover funding from cancellations the past year to fund HBCU/MI associates. This year, 5 HBCU/MI SFRPs declined after they were selected (and there was no one qualified to replace them with). The following table records HBCU/MI participation in this program.

SRP HBCU/MI Participation, By Year				
YEAR	SFRP		GSRP	
	Applicants	Participants	Applicants	Participants
1985	76	23	15	11
1986	70	18	20	10
1987	82	32	32	10
1988	53	17	23	14
1989	39	15	13	4
1990	43	14	17	3
1991	42	13	8	5
1992	70	13	9	5
1993	60	13	6	2
1994	90	16	11	6
1995	90	21	20	8
1996	119	27	18	7

6. SRP FUNDING SOURCES

Funding sources for the 1996 SRP were the AFOSR-provided slots for the basic contract and laboratory funds. Funding sources by category for the 1996 SRP selected participants are shown here.

1996 SRP FUNDING CATEGORY	SFRP	GSRP	HSAP
AFOSR Basic Allocation Funds	141	85	123
USAF Laboratory Funds	37	19	15
HBCU/MI By AFOSR (Using Procured Addn'l Funds)	10	5	0
TOTAL	188	109	138

SFRP - 150 were selected, but nine canceled too late to be replaced.
GSRP - 90 were selected, but five canceled too late to be replaced (10 allocations for the ALCs were withheld by AFOSR.)
HSAP - 125 were selected, but two canceled too late to be replaced.

7. COMPENSATION FOR PARTICIPANTS

Compensation for SRP participants, per five-day work week, is shown in this table.

1996 SRP Associate Compensation

PARTICIPANT CATEGORY	1991	1992	1993	1994	1995	1996
Faculty Members	$690	$718	$740	$740	$740	$770
Graduate Student (Master's Degree)	$425	$442	$455	$455	$455	$470
Graduate Student (Bachelor's Degree)	$365	$380	$391	$391	$391	$400
High School Student (First Year)	$200	$200	$200	$200	$200	$200
High School Student (Subsequent Years)	$240	$240	$240	$240	$240	$240

The program also offered associates whose homes were more than 50 miles from the laboratory an expense allowance (seven days per week) of $50/day for faculty and $40/day for graduate students. Transportation to the laboratory at the beginning of their tour and back to their home destinations at the end was also reimbursed for these participants. Of the combined SFRP and

GSRP associates, 65 % (194 out of 297) claimed travel reimbursements at an average round-trip cost of $780.

Faculty members were encouraged to visit their laboratories before their summer tour began. All costs of these orientation visits were reimbursed. Forty-five percent (85 out of 188) of faculty associates took orientation trips at an average cost of $444. By contrast, in 1993, 58 % of SFRP associates took orientation visits at an average cost of $685; that was the highest percentage of associates opting to take an orientation trip since RDL has administered the SRP, and the highest average cost of an orientation trip. These 1993 numbers are included to show the fluctuation which can occur in these numbers for planning purposes.

Program participants submitted biweekly vouchers countersigned by their laboratory research focal point, and RDL issued paychecks so as to arrive in associates' hands two weeks later.

In 1996, RDL implemented direct deposit as a payment option for SFRP and GSRP associates. There were some growing pains. Of the 128 associates who opted for direct deposit, 17 did not check to ensure that their financial institutions could support direct deposit (and they couldn't), and eight associates never did provide RDL with their banks' ABA number (direct deposit bank routing number), so only 103 associates actually participated in the direct deposit program. The remaining associates received their stipend and expense payments via checks sent in the US mail.

HSAP program participants were considered actual RDL employees, and their respective state and federal income tax and Social Security were withheld from their paychecks. By the nature of their independent research, SFRP and GSRP program participants were considered to be consultants or independent contractors. As such, SFRP and GSRP associates were responsible for their own income taxes, Social Security, and insurance.

8. CONTENTS OF THE 1996 REPORT

The complete set of reports for the 1996 SRP includes this program management report (Volume 1) augmented by fifteen volumes of final research reports by the 1996 associates, as indicated below:

1996 SRP Final Report Volume Assignments

LABORATORY	SFRP	GSRP	HSAP
Armstrong	2	7	12
Phillips	3	8	13
Rome	4	9	14
Wright	5A, 5B	10	15
AEDC, ALCs, WHMC	6	11	16

APPENDIX A -- PROGRAM STATISTICAL SUMMARY

A. Colleges/Universities Represented

Selected SFRP associates represented 169 different colleges, universities, and institutions, GSRP associates represented 95 different colleges, universities, and institutions.

B. States Represented

SFRP -Applicants came from 47 states plus Washington D.C. and Puerto Rico. Selectees represent 44 states plus Puerto Rico.

GSRP - Applicants came from 44 states and Puerto Rico. Selectees represent 32 states.

HSAP - Applicants came from thirteen states. Selectees represent nine states.

Total Number of Participants	
SFRP	188
GSRP	109
HSAP	138
TOTAL	435

Degrees Represented			
	SFRP	GSRP	TOTAL
Doctoral	184	1	185
Master's	4	48	52
Bachelor's	0	60	60
TOTAL	188	109	297

SFRP Academic Titles	
Assistant Professor	79
Associate Professor	59
Professor	42
Instructor	3
Chairman	0
Visiting Professor	1
Visiting Assoc. Prof.	0
Research Associate	4
TOTAL	188

Source of Learning About the SRP		
Category	Applicants	Selectees
Applied/participated in prior years	28%	34%
Colleague familiar with SRP	19%	16%
Brochure mailed to institution	23%	17%
Contact with Air Force laboratory	17%	23%
IEEE Spectrum	2%	1%
BIIHE	1%	1%
Other source	10%	8%
TOTAL	100%	100%

APPENDIX B -- SRP EVALUATION RESPONSES

1. OVERVIEW

Evaluations were completed and returned to RDL by four groups at the completion of the SRP. The number of respondents in each group is shown below.

Table B-1. Total SRP Evaluations Received

Evaluation Group	Responses
SFRP & GSRPs	275
HSAPs	113
USAF Laboratory Focal Points	84
USAF Laboratory HSAP Mentors	6

All groups indicate unanimous enthusiasm for the SRP experience.

The summarized recommendations for program improvement from both associates and laboratory personnel are listed below:

A. Better preparation on the labs' part prior to associates' arrival (i.e., office space, computer assets, clearly defined scope of work).

B. Faculty Associates suggest higher stipends for SFRP associates.

C. Both HSAP Air Force laboratory mentors and associates would like the summer tour extended from the current 8 weeks to either 10 or 11 weeks; the groups state it takes 4-6 weeks just to get high school students up-to-speed on what's going on at laboratory. (Note: this same argument was used to raise the faculty and graduate student participation time a few years ago.)

2. 1996 USAF LABORATORY FOCAL POINT (LFP) EVALUATION RESPONSES

The summarized results listed below are from the 84 LFP evaluations received.

1. LFP evaluations received and associate preferences:

Table B-2. Air Force LFP Evaluation Responses (By Type)

		How Many Associates Would You Prefer To Get ?								(% Response)			
		SFRP				GSRP (w/Univ Professor)				GSRP (w/o Univ Professor)			
Lab	Evals Recv'd	0	1	2	3+	0	1	2	3+	0	1	2	3+
AEDC	0	-	-	-	-	-	-	-	-	-	-	-	-
WHMC	0	-	-	-	-	-	-	-	-	-	-	-	-
AL	7	28	28	28	14	54	14	28	0	86	0	14	0
FJSRL	1	0	100	0	0	100	0	0	0	0	100	0	0
PL	25	40	40	16	4	88	12	0	0	84	12	4	0
RL	5	60	40	0	0	80	10	0	0	100	0	0	0
WL	46	30	43	20	6	78	17	4	0	93	4	2	0
Total	84	32%	50%	13%	5%	80%	11%	6%	0%	73%	23%	4%	0%

LFP Evaluation Summary. The summarized responses, by laboratory, are listed on the following page. LFPs were asked to rate the following questions on a scale from 1 (below average) to 5 (above average).

2. LFPs involved in SRP associate application evaluation process:
   a. Time available for evaluation of applications:
   b. Adequacy of applications for selection process:
3. Value of orientation trips:
4. Length of research tour:
5. a. Benefits of associate's work to laboratory:
   b. Benefits of associate's work to Air Force:
6. a. Enhancement of research qualifications for LFP and staff:
   b. Enhancement of research qualifications for SFRP associate:
   c. Enhancement of research qualifications for GSRP associate:
7. a. Enhancement of knowledge for LFP and staff:
   b. Enhancement of knowledge for SFRP associate:
   c. Enhancement of knowledge for GSRP associate:
8. Value of Air Force and university links:
9. Potential for future collaboration:
10. a. Your working relationship with SFRP:
    b. Your working relationship with GSRP:
11. Expenditure of your time worthwhile:

(Continued on next page)

12. Quality of program literature for associate:
13. a. Quality of RDL's communications with you:
    b. Quality of RDL's communications with associates:
14. Overall assessment of SRP:

Table B-3. Laboratory Focal Point Reponses to above questions

	AEDC	*AL*	*FJSRL*	*PL*	*RL*	*WHMC*	*WL*
# Evals Recv'd	0	7	1	14	5	0	46
Question #							
2	-	86 %	0 %	88 %	80 %	-	85 %
2a	-	4.3	n/a	3.8	4.0	-	3.6
2b	-	4.0	n/a	3.9	4.5	-	4.1
3	-	4.5	n/a	4.3	4.3	-	3.7
4	-	4.1	4.0	4.1	4.2	-	3.9
5a	-	4.3	5.0	4.3	4.6	-	4.4
5b	-	4.5	n/a	4.2	4.6	-	4.3
6a	-	4.5	5.0	4.0	4.4	-	4.3
6b	-	4.3	n/a	4.1	5.0	-	4.4
6c	-	3.7	5.0	3.5	5.0	-	4.3
7a	-	4.7	5.0	4.0	4.4	-	4.3
7b	-	4.3	n/a	4.2	5.0	-	4.4
7c	-	4.0	5.0	3.9	5.0	-	4.3
8	-	4.6	4.0	4.5	4.6	-	4.3
9	-	4.9	5.0	4.4	4.8	-	4.2
10a	-	5.0	n/a	4.6	4.6	-	4.6
10b	-	4.7	5.0	3.9	5.0	-	4.4
11	-	4.6	5.0	4.4	4.8	-	4.4
12	-	4.0	4.0	4.0	4.2	-	3.8
13a	-	3.2	4.0	3.5	3.8	-	3.4
13b	-	3.4	4.0	3.6	4.5	-	3.6
14	-	4.4	5.0	4.4	4.8	-	4.4

3. 1996 SFRP & GSRP EVALUATION RESPONSES

The summarized results listed below are from the 257 SFRP/GSRP evaluations received.

Associates were asked to rate the following questions on a scale from 1 (below average) to 5 (above average) - by Air Force base results and over-all results of the 1996 evaluations are listed after the questions.

1. The match between the laboratories research and your field:
2. Your working relationship with your LFP:
3. Enhancement of your academic qualifications:
4. Enhancement of your research qualifications:
5. Lab readiness for you: LFP, task, plan:
6. Lab readiness for you: equipment, supplies, facilities:
7. Lab resources:
8. Lab research and administrative support:
9. Adequacy of brochure and associate handbook:
10. RDL communications with you:
11. Overall payment procedures:
12. Overall assessment of the SRP:
13. a. Would you apply again?
    b. Will you continue this or related research?
14. Was length of your tour satisfactory?
15. Percentage of associates who experienced difficulties in finding housing:
16. Where did you stay during your SRP tour?
    a. At Home:
    b. With Friend:
    c. On Local Economy:
    d. Base Quarters:
17. Value of orientation visit:
    a. Essential:
    b. Convenient:
    c. Not Worth Cost:
    d. Not Used:

SFRP and GSRP associate's responses are listed in tabular format on the following page.

Table B-4. 1996 SFRP & GSRP Associate Responses to SRP Evaluation

	Arnold	Brooks	Edwards	Eglin	Griffis	Hanscom	Kelly	Kirtland	Lackland	Robins	Tyndall	WPAFB	average
# res	6	48	6	14	31	19	3	32	1	2	10	85	257
1	4.8	4.4	4.6	4.7	4.4	4.9	4.6	4.6	5.0	5.0	4.0	4.7	4.6
2	5.0	4.6	4.1	4.9	4.7	4.7	5.0	4.7	5.0	5.0	4.6	4.8	4.7
3	4.5	4.4	4.0	4.6	4.3	4.2	4.3	4.4	5.0	5.0	4.5	4.3	4.4
4	4.3	4.5	3.8	4.6	4.4	4.4	4.3	4.6	5.0	4.0	4.4	4.5	4.5
5	4.5	4.3	3.3	4.8	4.4	4.5	4.3	4.2	5.0	5.0	3.9	4.4	4.4
6	4.3	4.3	3.7	4.7	4.4	4.5	4.0	3.8	5.0	5.0	3.8	4.2	4.2
7	4.5	4.4	4.2	4.8	4.5	4.3	4.3	4.1	5.0	5.0	4.3	4.3	4.4
8	4.5	4.6	3.0	4.9	4.4	4.3	4.3	4.5	5.0	5.0	4.7	4.5	4.5
9	4.7	4.5	4.7	4.5	4.3	4.5	4.7	4.3	5.0	5.0	4.1	4.5	4.5
10	4.2	4.4	4.7	4.4	4.1	4.1	4.0	4.2	5.0	4.5	3.6	4.4	4.3
11	3.8	4.1	4.5	4.0	3.9	4.1	4.0	4.0	3.0	4.0	3.7	4.0	4.0
12	5.7	4.7	4.3	4.9	4.5	4.9	4.7	4.6	5.0	4.5	4.6	4.5	4.6
Numbers below are percentages													
13a	83	90	83	93	87	75	100	81	100	100	100	86	87
13b	100	89	83	100	94	98	100	94	100	100	100	94	93
14	83	96	100	90	87	80	100	92	100	100	70	84	88
15	17	6	0	33	20	76	33	25	0	100	20	8	39
16a	-	26	17	9	38	23	33	4	-	-	-	30	
16b	100	33	-	40	-	8	-	-	-	-	36	2	
16c	-	41	83	40	62	69	67	96	100	100	64	68	
16d	-	-	-	-	-	-	-	-	-	-	-	0	
17a	-	33	100	17	50	14	67	39	-	50	40	31	35
17b	-	21	-	17	10	14	-	24	-	50	20	16	16
17c	-	-	-	-	10	7	-	-	-	-	-	2	3
17d	100	46	-	66	30	69	33	37	100	-	40	51	46

4. 1996 USAF LABORATORY HSAP MENTOR EVALUATION RESPONSES

Not enough evaluations received (5 total) from Mentors to do useful summary.

5. 1996 HSAP EVALUATION RESPONSES

The summarized results listed below are from the 113 HSAP evaluations received.

HSAP apprentices were asked to rate the following questions on a scale from
1 (below average) to 5 (above average)

1. Your influence on selection of topic/type of work.
2. Working relationship with mentor, other lab scientists.
3. Enhancement of your academic qualifications.
4. Technically challenging work.
5. Lab readiness for you: mentor, task, work plan, equipment.
6. Influence on your career.
7. Increased interest in math/science.
8. Lab research & administrative support.
9. Adequacy of RDL's Apprentice Handbook and administrative materials.
10. Responsiveness of RDL communications.
11. Overall payment procedures.
12. Overall assessment of SRP value to you.
13. Would you apply again next year? Yes (92 %)
14. Will you pursue future studies related to this research? Yes (68 %)
15. Was Tour length satisfactory? Yes (82 %)

	Arnold	Brooks	Edwards	Eglin	Griffiss	Hanscom	Kirtland	Tyndall	WPAFB	Totals
# resp	5	19	7	15	13	2	7	5	40	113
1	2.8	3.3	3.4	3.5	3.4	4.0	3.2	3.6	3.6	3.4
2	4.4	4.6	4.5	4.8	4.6	4.0	4.4	4.0	4.6	4.6
3	4.0	4.2	4.1	4.3	4.5	5.0	4.3	4.6	4.4	4.4
4	3.6	3.9	4.0	4.5	4.2	5.0	4.6	3.8	4.3	4.2
5	4.4	4.1	3.7	4.5	4.1	3.0	3.9	3.6	3.9	4.0
6	3.2	3.6	3.6	4.1	3.8	5.0	3.3	3.8	3.6	3.7
7	2.8	4.1	4.0	3.9	3.9	5.0	3.6	4.0	4.0	3.9
8	3.8	4.1	4.0	4.3	4.0	4.0	4.3	3.8	4.3	4.2
9	4.4	3.6	4.1	4.1	3.5	4.0	3.9	4.0	3.7	3.8
10	4.0	3.8	4.1	3.7	4.1	4.0	3.9	2.4	3.8	3.8
11	4.2	4.2	3.7	3.9	3.8	3.0	3.7	2.6	3.7	3.8
12	4.0	4.5	4.9	4.6	4.6	5.0	4.6	4.2	4.3	4.5
Numbers below are percentages										
13	60%	95%	100%	100%	85%	100%	100%	100%	90%	92%
14	20%	80%	71%	80%	54%	100%	71%	80%	65%	68%
15	100%	70%	71%	100%	100%	50%	86%	60%	80%	82%

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AL/MD
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WL/ML
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PL/VT
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WL/MN
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TURBULENCE STATISTICS AND ENERGY BUDGET OF A TURBULENT SHEAR LAYER

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ABSTRACT

A two-component laser Doppler velocimeter "LDV" was employed to measure the flowfield of a generic tactical missile configuration in simulated powered flight. Mean velocities, normal and shear stresses, triple products, and higher order statistics measured by the LDV system working, in the off-axis forward scatter mode were analyzed. A balance of the turbulence energy equation has been performed in order to get a detailed insight into the turbulent shear layer behavior. The turbulent kinetic energy terms: production, diffusion, and convection terms were computed directly from the experimental data using central difference, while the viscous dissipation term was obtained from the balance of the kinetic energy equation. The analysis of the data was successful in identifying the various areas of interest in the flowfield where different turbulent transport mechanisms dominate. In addition, the data from this study will be available for upgrading advanced numerical codes.

Fast Infrared Image Registration and High Resolution Reconstruction for Real Time Applications

Mohammad S. Alam

Abstract

Forward looking infrared (FLIR) detector arrays generally produce low resolution images because the FLIR arrays can not be made sufficiently dense to yield a high sampling frequency using the current technology. Microscanning is an effective technique for reducing aliasing and increasing resolution in images produced by staring infrared imaging systems, which involves recording a sequence of frames through subpixel movements of the field of view on the detector array and then interlacing them to produce a high resolution image. The FLIR system is usually mounted on a moving platform, such as an aircraft, and the normal vibrations associated with the moving platform can be used to generate shifts in the FLIR recorded sequence of frames. Since a fixed number of frames is required for a given level of microscanning, and the shifts are random, some of the acquired frames may have almost similar shifts thus making them unusable for high resolution image reconstruction. In this paper, we utilize a modified version of the algorithm reported in Ref. 1 for estimating the shifts among the acquired frames and then utilize a k-nearest-neighbor approach for estimating the above mentioned missing frames to form the final high resolution image. Blurring by the detector and optics of the imaging system limits the increase in image resolution when microscanning is attempted at sub-pixel movements of less than half the detector width. We resolve this difficulty by the application of Wiener filter, designed using the MTF of the imaging system, to the microscanned images. Computer simulation and experimental results are presented to verify the effectiveness of the proposed technique. This technique is significantly faster than the alternate techniques, and is found to be especially suitable for real time applications.

TEMPORAL AND SPATIAL CHARACTERISATION OF A SYNCHRONOUSLY-PUMPED PERIODICALLY-POLED LITHIUM NIOBATE OPTICAL PARAMETRIC OSCILLATOR

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Abstract

To fully characterise the dynamics of a synchronously-pumped, periodically-poled, Lithium Niobate, optical parametric oscillator requires fast detection with high spatial-resolution. The introduction of a fiber-coupled fast detector, in parallel with standard techniques, has enabled clean experimental access to dynamics that are lost in the temporal and spatially averaging of large area, "slow" detectors. A fast rise-time ($\tau_{rise} \leq 25$ ps cf. $\tau_{pulse} \sim 100$ ps) fiber-coupled via a 25 μm diameter fiber to the experiment has enabled more detailed measurements of the on-axis pump depletion at the temporal center of the pulse, which was found to be typically 84% and appears to be limited by back conversion.

Maximum percentage pump-depletion occurs at the temporal and spatial center of the ~ 1MW/cm^2, 100 ps (FWHM) pump pulse. At higher irradiances the percentage pump depletion diminishes. A series of spatial profiles, that recorded the near-field irradiance of the transmitted pump at the rear of the nonlinear optical crystal, during the temporal center of the pulse shows the evolution of the transmitted pump as a function of incident power. The plots clearly show pump depletion and the onset of back-conversion of the signal to pump.

REDUCTION KINETICS IN A BATCH METALLIC IRON/WATER SYSTEM: EFFECT OF IRON/WATER EXPOSURE

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ABSTRACT

The reductive transformation rates of acetylene and carbon tetrachloride were observed in batch Fe^{o}/water systems. The pseudo-first order rate constants determined for both compounds were lower for "aged" (iron and water exposed prior to addition of the target analyte) relative to "fresh" (iron, water and the analyte mixed simultaneously) iron. The initial pseudo-first order rate constants were concentration-dependent, indicating nonlinear kinetics, in fresh iron Fe^{0}/water systems, while the pseudo-first order rate constants were independent of concentration in aged Fe^{0}/water systems. The rate of transformation slowed with time in the fresh Fe^{0}/water systems. Duration of iron exposure to water may be one contributor to the observed scatter in rate coefficients for individual compounds reported in the literature for Fe^{0}/water systems. An explanation consistent with the observations is that a low number of highly reactive "sites" present in the fresh iron are either blocked by precipitates or reaction products or eliminated by corrosion as the iron ages. Although initial reaction rates are classically used to determine reaction kinetics, initial rates in fresh Fe^{0}/water systems are not likely to hold practical relevance to applications proposed for groundwater and wastewater treatment. In treatment systems, the Fe^{0} is continuously exposed to water.

INVESTIGATION OF THE ELECTROCHEMILUMINESCENT PROPERTIES OF SEVERAL NATURAL AND SYNTHETIC COMPOUNDS

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Abstract

The fluorescence properties of a number of compounds of interest to the US Air Force were studied. Some of these compounds have been shown to give rise to electrochemiluminescence (ECL) under certain conditions. The fluorescence change was monitored over a period of time for these electrochemiluminescent compounds.

An electrochemiluminescent analysis system with spectral capabilities was constructed in-house from a photon counting spectrofluorometer and an electrochemical workstation (potentiostat). The purpose of this instrument was to study the ECL properties of several naturally occurring compounds such as extracted body fluids from tunicates, synthetic analogue compounds such as 2,3,4-tunichrome and 3,4,5-tunichrome and diaminotoluenes in the presence and absence of metal ions.

By combining these two instruments the intention was to probe the electrochemical reactions and obtain ECL spectra for a number of compounds. These spectra could then be compared with fluorescent spectra to help identify emitting species. Synthetic ECL compounds were used as models of naturally occurring biological ECL systems to further elucidate the ECL reaction mechanisms.

A FAST FOURIER TRANSFORM ANALYSIS OF PILOT INDUCED OSCILLATIONS

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Abstract

During the summer of 1996 a program was initiated by the authors to study the characteristics of pilot induced oscillations (PIOs). The long term goals are

- to develop a methodology to take time history data from flight or ground based simulation and determine if a vehicle is PIO prone,
- to determine if a PIO actually occurred in a time history record,
- to develop a non-real-time analysis tool to determine from flight simulator time history data if PIOs occurred so that simulation engineers can help insure consistency between pilot comments, Cooper-Harper ratings, PIO ratings and time history data, and
- to develop a real-time capability of detecting a PIO fast enough to take action to prevent the full development of the PIO.

Results obtained over the period 7/1/96-8/23/96 deal primarily with the first goal and are described in this report. A computer analysis tool is developed in which fast fourier transforms are used to determine

- resonant frequency and output phase angles at the resonant frequency,
- predictions of PIO susceptibility using the Smith-Geddes PIO criteria.

The following preliminary results are highly encouraging.

- 13 of 14 configurations which experienced PIOs were correctly identified.
- In 12 additional configurations 6 were correctly identified as being not PIO prone. Results for the remaining 6 configurations were complicated by multiple resonances that confuse the resonance detector. However, depending on the choice of resonant frequency the correct classification is made for each of the 6 configurations.
- The occurrence of multiple resonances is closely associated with configurations that are not PIO prone.
- continued development of the resonance detector is planned.

A STUDY OF QUANTUM WELLS FORMED IN $Al_xGa_{1-x}As_ySb_{1-y}/In_zGa_{1-z}As/Al_xGa_{1-x}As_ySb_{1-y}$ HETEROSTRCUTURES

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Abstract

AlGaAsSb/InGaAs/AlGaAsSb quantum wells are investigated for possible applications in ultra low noise high electron mobility transistors (HEMTs) operating at millimeter wavelength. Schrödinger and Poisson equations are solved self-consistently to calculate the quantum mechanical properties of *AlGaAsSb/InGaAs/AlGaAsSb* single quantum wells formed in HEMTs. The two dimensional electron gas (2DEG) distribution is calculated and shows excellent confinement both at room temperature and at 77K. The variation of the average distance of the electron cloud, from the first heterointerface, with the 2DEG concentration is a strong function of the quantum well (QW) width. A minimum 2DEG concentration threshold, dictated by the QW width and the unintentional doping level of the substrate, exists at room temperature. This effect may prohibit the pinching-off of the channel at room temperature, especially for wide QWs. The room temperature pinch-off properties are strongly affected by the *Al* mole fraction in the buffer layer, the *In* mole fraction in the channel and the unintentional doping level of the lattice matched quaternary buffer. A higher *Al* mole fraction in the buffer along with a lower *In* mole fraction in the channel results in superior pinch-off characteristic. The use of *InAs* as channel material imposes stricter condtions on the composition and the unintentional doping of the buffer layer, while with decreasing *In* mole fraction the restriction is relaxed. Care must be taken to properly choose the *Al* and *In* mole fractions, inability to do that may result in a type-II broken-band or staggered-band configuration.

TEXTURE AND MICROSTRUCTURE
OF HOT ROLLED Ti-6Al-4V

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Abstract

The effect of initial microstructure, hot-working parameters, and post-processing heat treatments on Ti-6Al-4V were studied. Included in the studies were optical metallography, crystallographic texture measurements using back-reflection pole-figures, and micro-texture determination using orientation image microscopy. The results demonstrate strong dependency on the processing parameters, and the existence of micro-texture even in some of the cases when overall the crytallographic orientation is random.

DEVELOPMENT OF A PRIMARY CELL CULTURE PREPARATION FOR STUDYING MECHANISMS GOVERNING CIRCADIAN RHYTHMICITY IN SUPRACHIASMATIC NEURONS.

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Abstract

The aim of the present study was to establish a cell culture system for characterizing the physiological and biochemical processes by which neuronal activity of the suprachiasmatic nucleus (SCN) is regulated. Whole-cell patch clamp recording experiments were conducted in both hippocampal and hypothalamic neurons in primary cultures from embryonic and postnatal tissue, respectively. Morphological examinations revealed a much more heterogeneous population of neurons in hypothalamic cultures and a lower percentage of cell survival. Tight membrane seals for stable recordings were difficult to achieve. However, spontaneous and evoked action potentials were observed indicating that voltage-gated ionic channels were functional in hypothalamic neurons culture day 7 and 14 when recordings were carried out. These results provide a foundation for our on going experiments to optimize the health and survival of SCN neurons in hypothalamic cultures.

Microparticle Bioluminescence

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Abstract

The summer research period was devoted to several tasks: an experimental study of the operation and stability of an electrodynamic balance of potential use in the detection of bioluminescent emission from microparticles; a number of discussions on research activities with colleagues; participation in a research conference held each summer at the Edgewood laboratory; and, establishing contacts with AFOSR with regard to ongoing research interests.

AN ASSESSMENT OF THE CURRENT STATE OF THE ART OF STAP FROM AN ELECTROMAGNETICS POINT OF VIEW

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Abstract

An assessment, from an Electromagnetics point of view, of the state of the art of Space-Time Adaptive Processing (STAP) for radars is given. The validity of certain assumptions made for the antenna system of the radar is discussed. The importance of some of the electromagnetics effects not explicitly included in the STAP algorithms are briefly summarized. These effects include the mutual coupling of the elements of the array, the transmit/receive pattern of individual elements of the array, the near-field-scattering from objects close to the radar, and the effect of a radome housing the antenna. Once the above-mentioned electromagnetic effects are included in a STAP algorithm, one can not assume electrically identical elements of the array antenna. This will further complicate the algorithm.

EVALUATION OF CURRENT JET ENGINE PERFORMANCE PARAMETERS ARCHIVE, RETRIEVAL, AND DIAGNOSTIC SYSTEM, AND IMPLEMENTATION OF ADVANCED TECHNOLOGY TO IMPROVE SYSTEM

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Abstract

Engine test cell parameter data is used to determine the reliability of an engine, and the extent of any necessary repairs to the engine. This data is currently stored on a VAX11780 machine, and graphic output retrieved from a Tektronix plotter. This project successful replaced the current data archive and retrieval system with a less expensive, easier to use Personal Computer based system. Increased diagnostic capabilities were achieved through the implementation of P.C. based programs.

ANALYSIS OF FATIGUE CRACK GROWTH RATE DATA FOR ALUMINUM ALLOYS DAMAGED BY PRIOR CORROSION

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Abstract

The differences in fatigue crack propagation behavior in 7075-T6 aluminum alloy between specimens damaged by corrosion and those in a baseline (noncorroded) condition are examined using a statistical hypothesis test. Middle tension plate specimens were corroded on one side in the laboratory and subjected to constant load amplitude (K-increasing) tests in dry and moist air environments. The results show that there is a statistically-significant increase in fatigue crack growth rates in the corroded material for stress intensity values based on nominal thickness. When the specimen thicknesses were reduced to account for corrosion material loss, the difference disappeared in most of the instances examined here. In one case, the thickness correction was found to predict fatigue crack growth rates that were *slower* in the corroded material. This anomalous result suggests that full thickness corrections may not be appropriate at higher stress intensity ranges.

Formal Verification Using ORA Larch/VHDL Theorem Prover

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Abstract

This report describes the research conducted in the field of formal hardware verification. Odyssey Research Associate Inc. (ORA) has develpoped a hardware verification environment Larch/VHDL that includes an interactive theorem prover (Penelope). Larch/VHDL is used to prove that certain classes of logic circuits can be verified in a systematic way. Accordingly, a step-by-step verification methodology is being developed to describe the process of performing a formal proof that a VHDL design at the logical and components level satisfies its specification. An example of a full adder designed using AND, OR, NOT, and XOR logic gates has been developed and proved to meet its design specifications using the developed methodology. The same proof steps are applied to prove the correctness of more complex logic structures (a four-bit adder with overflow). The same process can be used to generate algorithms for automating the proof process. Also, proposed research projects based upon the Larch/VHDL tool to make it more acceptable and usable by both universities and industry are being investigated. These projects include developing automated proof at the gate level, establishing fault models and developing its formal specifications, developing formal specifications for the testability of a logic circuit, generating test patterns, and parallelizing Larch/VHDL to reduce its execution time.

FORMAL SPECIFICATION AND VERIFICATION OF MISSI ARCHITECURE USING SPIN

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Abstract

In this document we formally specify and verify a part of the Multilevel Information System Security Initiative (MISSI). MISSI is a National Security Agency (NSA) program, designed to send protected messages over unprotected networks such as Internet. MISSI uses several kinds of cryptography for protecting the messages. Cryptography is accomplished using a credit card sized Personal Computer Memory card Interface Association (PCMCIA) card called the FORTEZZA Crypto Card (or "Card", for short).

We constructed a formal specification of sending e-mail using MISSI. We used formal language called Promela, based on Hoare's CSP. We verified the model using automated model checker SPIN, developed by AT&T.

DECONVOLUTION OF THE SPACE-TIME RADAR SPECTRUM

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Abstract

Modern processing of radar data collected through an antenna array comprising a number of elements takes advantage of the structure of the data in both space and time. In order to exploit that spatio-temporal structure, data are arranged in a three-dimensional "Datacube", where each of the dimensions corresponds to the different antenna elements, the consecutive radar pulses in a Coherent Pulse Interval (CPI) and to different range gates . The two-dimensional FFT of data collected for a single range gate (i.e., *a space-time snapshot*), reveals the presence of scatterers of interest, i.e., targets, in terms of their relative velocity with respect to the radar system (Doppler frequency) and the azimuth angle with respect to the array normal. This Space-Time Radar Spectrum may, on the other hand, incorporate the representations of unwanted phenomena, such as the radar return due to scatterers that are not relevant to the detection process, or "clutter", and the presence of jamming signals designed to obscure the existence of relevant targets. Due to the operational principles of the radar system the manifestation of a target in the space-time spectrum will have a structure that depends on the number of elements in the antenna array, N, and the number of pulses in each CPI, M. This report explores the possibility of using the advanced knowledge of the structure of the spectral configurations caused by valid targets to simplify the presentation of the velocity / angle characteristics of the targets, by the process of ***deconvolution***. Since some unwanted components of the radar signal, such as clutter, do not necessarily have the same structure in their spectral manifestation as valid targets, this report also explores the possibility of using the deconvolution process to aid in the filtering of those unwanted components. The discussion is developed around examples involving both simulated and real radar data.

THE USE OF WAVELETS AND NEURAL NETWORKS IN DATA COMPRESSION AND FUSION WITH RESPECT TO TARGET IDENTIFICATION

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Abstract

The usefulness of wavelets in digital and signal processing has been widely accepted and appreciated for the past several years. Also, the need for data compression as well as the ability to train networks via radial basis functions has been known for the past decade. This research was conducted for the purpose to ascertain the benefits of using wavelets for data compression followed by the use of a radial basis function to determine if data fusion in the context of infared and passive millimeter wave imaging can benefit the identificatiion of potential targets as well as discriminate between a non-target. The study showed that data compression can be attained while retaining a high percentage of image characteristics of a target. Also, it is conjectured that data fusion most likely enhances target identification. However, further study needs to be udertaken to determine under what conditions data fusion is most successful. Finally, further investigation needs to be done to determine how well a non-target can be discriminated from a non-target using neural networks.

TESTING OF A DUAL-BAND INFRARED FOCAL PLANE ARRAY AND AN INFRARED CAMERA SYSTEM

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ABSTRACT

Progress was made on the development of a portable test station for Lockheed Martin's dual-band IR FPA. The appropriate method for running the required clocks was determined to be an Altera EPM5064 programmable logic device combined with a test station being built by Wallace Instruments. The timing patterns required for operation of the dual-band FPA were determined. A second project was the evaluation of an Infrared Camera system. The greatest limitations apparent in this initial evaluation appeared to be software related. The primary problem is the inability to obtain raw data from the FPA and the lack of documentation explaining how the raw data was processed by the software. This situation resulted in skewed histograms of pixel values obtained while viewing a uniform scene. Such histograms should have been normally distributed, but instead appeared to have secondary peaks. Subtraction of one frame of data from another was successful in eliminating the effects which skewed the histograms.

TILT SENSING TECHNIQUE WITH A SMALL APERTURE BEAM AND RELATED PHYSICAL PHENOMENA

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Abstract

A tilt sensing technique which does not require transmitting laser irradiance through the main optical train is described. The method exploits a small aperture beam transmitted from behind a portion of the primary mirror of the main telescope. The main and auxiliary telescopes are used simultaneously to measure the LGS image motion. A one-axis component of the full aperture tilt is determined by subtracting the tilt measured with the main telescope, from that measured with an auxiliary one. The two effects, namely a tilt angular anisoplanatism and tilt focus anisoplanatism, which determine the required parameters of the tilt measurement scheme and the tilt sensing error, are studied by taking into account a finite outer scale of turbulence and vertical distribution of the strength of turbulence. A tilt angular correlation scale and tilt averaging function are quantitatively estimated. Parameters of the tilt measurement scheme are determined. The two experiments, namely Polaris jitter and Moon-edge jitter experiments are designed and carried out. The goal of the first experiment is to determine the effect of non-Kolmogorov stratospheric turbulence on the star image motion. A second experiment was designed to study a tilt angular correlation and to obtain the data which are required to design a tilt sensing experiment with a LGS. The two additional experiments are designed as a part of the Summer Research Program. A technical objective of one of these experiments is to study a LGS image motion for a monostatic laser beacon method and to test the technique for remote sensing of the vertical profile of $C_n^2(h)$ by using a modified LGS scheme. The technical objective of another experiment is to demonstrate and test a technique for sensing full aperture tilt with a laser guide star.

TURBINE ENGINE BLADE VIBRATION ANALYSIS SYSTEM

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Abstract

This report describes a system which is capable of reconstructing and displaying the actual movement of a vibrating compressor blade in a turbine engine. The system combines the outputs of real-time strain gage vibration measurements with a finite element model of the blade to accomplish this task. Various error analysis tools help the user to verify the results. The system is integrated with a graphical user interface for ease of operation and fast, on-line display of the results. The report discusses the design specifications and implementation of the system and concludes with initial application results.

ENHANCING TINKER'S RASTER-TO-VECTOR CAPABILITIES

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Abstract

This paper presents an evaluation of the AUDRE Conversion System for the ability to convert schematics from scanned raster to vector format. Particular attention is placed on the trade-off between automatic recognition versus manual insertion of electronic symbols. Text recognition is not considered. The evaluation shows that AUDRE successfully performs the raster to vector conversion. However, with the several suggested improvements, the entire process could be enhanced greatly and draw closer to the desired goal of fully automated document conversion.

LACK OF EFFECT OF ULTRAWIDEBAND RADIATION ON PENTYLENETETRAZOL-INDUCED CONVULSIONS IN RATS

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Abstract

The purpose of the present study was to determine whether exposure to high peak power, short pulses of ultrawideband (UWB) electromagnetic radiation would affect susceptibility to convulsions caused by pentylenetetrazol (PTZ). The ED_{99} for PTZ-induced convulsions was determined to be 89.174 mg/kg, and this was the dose administered to 2 groups of rats, one sham exposed and one exposed to UWB produced by a Kentech pulse generator. Parameters for the Kentech were 55kV/m peak E field, 30 ps rise time, 1.8 ns pulse width and 1 kHz pulse repetition rate. Two additional groups were administered saline injections and received either a sham or UWB exposure. UWB had no visible effect on saline injected animals, nor did it affect latency to convulsion, length of convulsion or lethality produced by PTZ when these rats were compared to sham exposed animals that received PTZ.

PERFORMANCE ANALYSIS AND SIMULATION RESULTS OF DELAY AND MULTIPLY RECEIVERS PROCESSING A SPREAD SPECTRUM MODULATED FLIP-WAVE SIGNAL GENERATED FROM HIGH BANDWIDTH EFFICIENCY PULSES

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Abstract

This report presents performance results of delay and (complex) multiply (D & M) receivers processing a specific spread spectrum modulated digital communication signal. The signal structure involves various types of high bandwidth efficiency (HBE) pulses that affect the spectrum of the output generated by the D & M receivers. Although mathematical models and analytical methods have been used to describe and partly set up the problem solution, the performance results of interest are obtained strictly via computer methods utilizing block oriented simulation software. More specifically, the signal of interest, having a unique structure, was mathematically described and generated by the simulation software. This so-called flip-wave signal is generated by a random data signal whose spectrum is spread using pseudo-noise (binary) codes. Much of this effort involved a determination of the detectability of the spectrally spread signal by D & M receivers as a function of different waveshapes and modulation of the amplitude of the waveforms associated with the pseudo-noise codes. The different waveshapes considered included rectangular, raised cosine, and sinc function pulses. Amplitude modulation involving these waveforms was of discrete type that could involve four, six, or up to eight levels. The results demonstrated in general (but not in every specific case), that amplitude modulation and sinc function shaping tended to result in a signal that was more difficult to detect by a D & M receiver. Under such conditions, the signal constructed appeared as nearly featureless. Furthermore, since two receivers were considered, namely the baseband and the carrier D & M device, it was found in essentially every case, that the latter was not as effective as the former, in identifying the presence of the signal under study given the spectral strength of its output at critical frequencies. Not all possible cases and operational scenarios could be considered in this effort. Therefore, in a certain sense, the work completed as part of this project, can be viewed as the starting point for more sophisticated performance evaluation efforts in which a signal detection algorithm is considered as operating jointly with the D & M receiver and practical effects, such as noise, co-channel interference and the effect of multipath propagation are included in studies and system simulations.

Alley C. Butler

Robot Path Planning into Cavities defined by Splines

ABSTRACT

This report describes the development of a robot path planning system in which computational geometry is used to generate an optimal robot path. The architecture of this system makes extensive use of B-splines. The system is designed to support non-destructive testing of jet engine parts which contain multiple cavities. These cavities are modeled by B-splines, and a Voronoi tree is developed by finding the intersection points for offset curves or hodographs from the B-splines. In a manner similar to the Voronoi diagram, the Voronoi tree is maximally distant from adjacent obstacles. This Voronoi tree, therefore, represents the path with greatest clearance. For this reason, the Voronoi tree is used to guide path development for a single robot manipulator which is inserted into the cavities. The addition of potential field methods allow development of complete path information for the robot manipulator, based on attaching the potential field to the robot arm. In this report, a literature survey is provided, and the techniques for finding a Voronoi tree are described. Next, the adaptation of these techniques to develop manipulator paths using a potential field is discussed. Further evolution of the methodology is outlined, and conclusions with recommendations are provided.

Importance of Current Crowding and Self-heating Effects in a CdS/LaS Cold Cathode

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ABSTRACT

We analyze the importance of current crowding in a new cold cathode emitter which consists of a thin wide bandgap semiconductor material sandwiched between a metallic or heavily doped semiconductor and a low work function semimetallic thin film. Potential material candidates are suggested to achieve low-voltage (< 10 V), room-temperature cold cathode operation with emission currents of several tens of A/ cm^2. We calculate the lateral potential drop which occurs across the emission window of cold cathodes with rectangular geometry and describe its effects on the emitted current density profile. The power dissipation in the cold cathode is calculated as a function of a dimensionless parameter characterizing the importance of current crowding. We determine the range of dc bias over which cold cathodes of different width must be operated to minimize current crowding and self-heating effects.

TRANSIENT STUDIES OF THE EFFECTS OF FIRE SUPPRESSANTS IN A WELL-STIRRED COMBUSTOR

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Abstract

The effects of three different fire suppressants on the transient behavior of the composition of the effluent gas from a combustor were investigated in an experimental program conducted at the Well Stirred Reactor (WSR) facility at Wright-Patterson Air Force Base during the months of July and August 1996. A quadrupole mass spectrometer, that was originally designed and constructed to sample rocket exhaust gases, was used to sample the effluent gas composition from the WSR. These experiments employed premixed propane/air and methane/air gas mixtures at near-atmospheric pressure in the WSR. Transient measurements were performed on the effects of injecting the fire suppressants Halon 1301 (CF_3Br), pentafluoroethane (C_2HF_5, HFC-125), and trifluoroiodomethane (CF_3I) into air/fuel mixtures at various concentration levels using a fast, pulsed valve system. Selected results from the experimental program are presented and discussed. It was concluded that the three fire suppressants exhibit some similarities in their behavior in combustion environments, as well as some distinct differences

In order to interpret the resultant transient responses of product species, it is essential to know the time response of the entire reactor system. Consequently, a fluid mechanical model of the jet ring distributor was developed. Results from this model were then used to simulate the transient response of the jet ring to tracer pulses. It was concluded that the jet ring effectively introduces a significant amount of dispersion into the system response. This is not due to fluid mechanical "mixing," but rather to the variable time delay imposed by the jet tubes at different locations along the jet ring; i.e., those near the inlet feed tube have a faster response than those further along the ring. This also means that the characteristic decay times observed for inert tracer pulses will differ from the intrinsic residence time of the WSR, and they will also be more similar; i.e., the tracer response is "integrated" somewhat by the jet ring.

A considerable amount of data were obtained during the experimental program. The detailed analysis of these data will be performed with the aid of the preceding model of the reactor system, coupled with the CHEMKIN II package of codes developed to model complex multispecies, multireaction systems, such as the combustion environment in the WSR. It is anticipated that the project will be continued in some manner so that this work can be completed and brought to a successful conclusion.

EXAMINATION OF CRITICAL ISSUES IN THE USE OF ^{178}Hf FOR HIGH ENERGY DENSITY APPLICATIONS

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Abstract

The second nuclear isomer of ^{178}Hf stores 2.445 MeV per nucleus for a halflife of 31 years. Therefore, samples containing this isomer provide an attractive high energy density material, on the order of a gigaJoule per gram. This stored energy is normally released as gamma rays during the spontaneous decay of the isomer. However, experimental studies have indicated that it may be possible to trigger this release without resorting to fission or fusion reactions (with their negative aspects). In this event, ^{178}Hf may prove to be important for a number of applications related to the mission of the US Air Force, including rocket propulsion, agent defeat and advanced light source or laser development. This report examines a number of critical issues which must be resolved prior to a complete evaluation of the potential for the 31-year isomer of ^{178}Hf. The status of experimental and theoretical efforts along these lines will be discussed.

Assessment of the Reliability of Ground-Based Observers for the Detection of Aircraft

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University of South Florida

Jason McCarley

Department of Psychology
University of Louisville

Abstract

In situations in which ground-based lasers are propagated through the atmosphere, either for entertainment or scientific pursuits, there is the chance that aircrew may be exposed to the beam. In most cases this exposure would not be eye-hazardous, but the effects of flashblindness and veiling glare can nonetheless impair mission performance, with potentially catastrophic consequences. In most situations where such lasers are employed, ground-based observers attempt to identify aircraft that are in or near the beam path; occasionally these observers are aided by FAA radar feeds that can assist them in locating these aircraft. In this study we attempt to determine the effectiveness of observers in the detection of aircraft under a variety of conditions, including day versus night, and with and without the assistance of a radar feed. Preliminary data collected at Sandia National Labs in Albuquerque, NM, suggest several points. First, detection range is very much greater at night than in the day, probably due to the high contrast between the aircraft and night sky from aircraft lighting, and the increased visual sensitivity of the observers in scotopic viewing. Second, the assistance of a radar feed for daytime observation is important in aircraft detection, not so much to increase the range at which the aircraft is visually acquired, but to increase the likelihood that the aircraft will be detected at all. In further analysis of the complete data set we will examine the impact of various ground and sky conditions that can mitigate the performance of the observers.

A STUDY ON HARTMANN SENSOR APPLICATION TO FLOW AERO-OPTICS INVESTIGATION THROUGH TOMOGRAPHIC RECONSTRUCTION

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Abstract

The aero-optics research group of the Lasers and Imaging Directorate at Phillips Laboratory conducts tomographic reconstruction for imaging three-dimensional flow fields by employing the Hartmann sensor. The system based on Hartmann sensors can provide rapid sampling of two-dimensional projections of a field, that is, real-time capability in data acquisition. However, it provides integrated gradient-data along the optical paths of probing rays. The current practice of reconstruction has depended on an existing computational tomographic technique that utilizes integrated optical pathlength data. During this summer research, the investigator analyzed the currently employed software for reconstruction, formulated a new topographic reconstruction algorithm, and provide a strategy for assimilating these two techniques into a single package. He also investigated a strategy and conducted concurrent analysis for achieving a long-term goal of utilizing a currently-available wind-tunnel facility, that is, Turbulent Boundary Layer Generator, for aero-optics research. This can be accomplished by tomographically reconstructing flow fields with the Hartmann sensor.

A NOVEL COMPATIBILITY/EQUILIBRIUM BASED ITERATIVE POST-PROCESSING APPROACH FOR AXISYMMETRIC BRITTLE MATRIX COMPOSITES

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Abstract

A semi-analytical iterative approach for enhancing the existing two-dimensional quasi-continuous axisymmetric stress field for a brittle matrix micro-composite (i. e., a single fiber surrounded by a concentric matrix cylinder), is presented. The existing solution employs Reissner's variational theorem in conjunction with an equilibrium stress field in which the radial (r-) dependence is assumed *a priori*.

In the present approach, the stress distribution in the radial direction obtained from the afore-cited variational model is improved *a posteriori* through an iterative approach that involves successive substitution of the previously computed strains (or stresses) into the equations of compatibility and equilibrium. The boundary/interface conditions at r = constant surfaces are satisfied in the pointwise sense. However, this process leaves the end boundary conditions in the axial direction (i.e., at surfaces z = constant) undefined thus rendering the boundary-value formulation ill-posed. This ill-posedness is removed by introducing appropriate boundary error terms that help satisfy the end boundary conditions at surfaces z = constant. As a first step, an approximate plane strain version of the present solution is implemented in a FORTRAN code. An illustrative thermal stress problem is solved and used to compare with the existing variational solution .

A STUDY OF DATA COMPRESSION BASED ON HUMAN VISUAL PERCEPTION

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Abstract

With the advances in hardware and software technology, multimedia that includes text, audio, imagery, and video is becoming part of our daily computing life. Even with faster computers, larger storage capacity, and higher communication bandwidth, data compression is still needed to overcome greater demand of multimedia data volume. This report presents a study on the various data compression techniques. including JPEG and MPEG, wavelet, and fractal image compression. In particular, issues related to compression schemes based on human visual perception are addressed. Research effort in the past in the are of human vision based compression techniques primarily focused on still images. A good example is the recommanded quantization matrix for discrete cosine transformation in JPEG and MPEG compression. Various quantization matrices have been proposed to accommodate different imagery as well as viewing conditions. Human vision models can also be incorporated in other image compression algorithms such as those using wavelets and fractals. Video compression based on human perception presents a great deal of challenge not only in terms of increased data volume but also in terms of more complicated spatial-temporal human vision model. This report also discusses possible study of vision based video compression techniques as well as available hardware technologies that facilitate the task.

A STUDY OF OPTOELECTRONIC FEEDBACK SUSTAINED PULSATION OF LASER DIODES AT 1300 nm AND 780 nm

by

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J. Kann, R. K. Boncek, D. J. Grucza

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Abstract

In this report, some new experimental results are presented on optoelectronic feedback sustained pulsation in multi-quantum well InGaAsP Laser diodes at 1300 nm and AlGaAs injection laser diodes at 780 nm. The feedback intensity plays an important role in feedback sustained pulsation in these two different kinds of laser diodes. It was found a bistability of the feedback oscillating modes appeared as increasing the feedback intensity. It was observed that jumps between feedback oscillating modes occurred as varying the drive current. However, in between jumps, the frequency response to the drive current is not zero, instead, it depends on the feedback intensity. In addition, amplitude modulations in LD at 1300 nm are demonstrated using FSP at 1 GHz as the subcarriers..

OPTICAL AND NON-DESTRUCTIVE METHODS TO DETERMINE THE COMPOSITION AND THICKNESS OF AN $IN_XGA_{1-X}AS$/INP MULTILAYER STACK

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Abstract

Two optical methods which are easy, fast and nondestructive to determine the composition and thickness of each epitaxial layer in a $In_xGa_{1-x}As$ /InP multilayer stack on InP are reported here. One is the optical reflectivity method and the other is the photoluminescence method. It is shown that the first method is very convenient and accurate as long as the model for the dependence of the refractive index of $In_xGa_{1-x}As$ on the composition x and wavelength λ is accurate. For the photoluminescence method, only preliminary result is shown here and more work needs to be done.

A SEQUENTIAL OPTIMIZATION ALGORITHM FOR PERSONNEL ASSIGNMENT BASED ON CUT-OFF PROFILES AND A REVISION OF THE BROGDEN TABLE

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Abstract

Two problems in the methodological research and practice of personnel psychology are considered. A sequential optimization algorithm flexible enough to incorporate various hard-to-quantify constraints on the personnel assignment solutions is developed and assessed by Monte Carlo simulation. The results show that the algorithm is able to produce solutions with allocation efficiency close to the theoretical ceiling. The open problem of establishing an accurate adjustment formula for the Brogden (1959) table used in estimating assignment benefits is solved by taking a distribution-theoretic approach.

NEW TECHNIQUES FOR NON-COOPERATIVE TARGET IDENTIFICATION

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ABSTRACT

A new methodology for identifying aircraft using radar range profiles through application of the generalized likelihood ratio test is developed. The new identifier maximizes the probability of target identification, at a prespecified Type I error, in dependent Gaussian noise, and it identifies the target without the compromise of making forced decisions. When subjected to more restrictive conditions, it reduces to other classes of identifiers, including the maximal cross-correlation identifier and, after power transformation, the shortest Euclidean distance identifier. All system parameters necessary for implementation are estimated, and the procedure does not require any prior information about the statistical properties of the measured data. The results of experiments with an extensive real high range resolution (HRR) data set demonstrate that the proposed identifier attains reasonable probability of detection and is amenable to real time processing. It also suggests the feasibility of target identification using synthetic signatures, and the implementation, except for minor modifications, parallels its counterpart using measured signatures.

A Feasibility Study of Re-Engineering and Re-Manufacturing Aircraft Structural Components Using Laser Scanning

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Abstract

Last summer a feasibility study was initiated to study the applicability of laser scanning to aircraft structural components manufacturing. A sample part, F-15's leading edge rib, was scanned by laser scanners and the scan data was used to create a CAD model at Laser Design Inc. and generate toolpaths at Sharnoa Corp, respectively. A part was then produced by machining an aluminum block using toolpaths generated by Sharnoa. This study results clearly indicate that laser scanning had matured to a stage that they could capture and reproduce intricate surface details typically present in the aircraft structural components. However, in spite of the promising results, the data obtained was not convincing enough for the WR-ALC to implement this new technology on their production floor.

A follow-up study was conducted this year. To broaden this study's scope, two more sample parts, a F-15's canopy fitting and a C-141's forward latch fitting, were also included in this study. A long term plan that can demonstrate laser scanning is capable of quickly and accurately duplicating an existing part was also made. Because of time constraints, this summer's effort was concentrated only on the canopy fitting since it is one of the most difficult parts that WR-ALC had to manufacture. Based on the initial scanning and surfacing results for this part, one can further conclude that laser scanning can significantly reduce the model creation time as well as the skill levels required to create the CAD model. The question of its accuracy when used in the aircraft structural components manufacturing will be answered later by the final results from the canopy fitting and the other two sample parts.

LASER VAPOR SCREEN FLOW VISUALIZATION TECHNIQUE

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Abstract

The vapor screen flow visualization method is fully described. Naturally occurring vaporization patterns are used to illustrate flow features that could be made visible using the method in the wind tunnel. Natural vaporization usually occurs in vortices on vehicles that are at large angles-of-attack. Previous wind tunnel use of the vapor screen method is examined with emphasis on the improvements that have been made over time, leading to the present use of a laser light sheet to illuminate the water droplets. The system used at NASA Langley is described in some detail, including the optics. Equations needed for analyzing the humidity conditions in a wind tunnel are given. The humidity conditions of previous tests are analyzed in some detail. It is shown that the method depends on the total amount of water vapor in the tunnel circuit rather than the specific humidity. Relative humidity approaching 1.0 in the stilling chamber is required to apply the technique to subsonic flow fields. Mie scattering patterns for various droplet sizes are computed to illustrate the benefits of viewing the laser light sheet from 50° rather than 90°.

OF MATCH MAKER AND METRICS

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Abstract

The task of a sensor manager is to improve the performance of the individual avionics sensors by coordinating their activities based on the sensor manager's best estimate of the future. This report continues the study of scheduling algorithms for the sensor manager. It is composed of two individual reports, Match Maker and Metrics. Match Maker offers a modification to the crossover algorithm of genetic algorithms that shows promise of speeding convergence of the genetic search. Metrics is a discussion of the role the choice of the evaluation function has on the performance of scheduling algorithms.

EVALUATION OF SEMICONDUCTOR CONFIGURATIONS AS SOURCES FOR OPTICALLY INDUCED MICROWAVE PULSES

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Abstract

The use of optically induced, DC accelerated, semiconductor carriers as a source of picosecond μ wave pulses is examined. The purpose of this study was to determine 1) whether multiple phase shifted (optical) pulses could be simultaneously generated on a single semiconductor element, and 2) whether two or more, in line, elements could be stimulated with a single optical pulse. Such variations in excitation methods have potential for simultaneously providing the source and phase control necessary for a re-configurable, target recognition, antenna array. The efficacy of both technique are demonstrated in this preliminary study. Also, the gain which could be realized from cooling the semiconductor sources was evaluated for one specimen material. Phase differences for multiple pulses were observed and directly related to the spatial position of the optical pulses on the semiconductor with respect to the μ wave detector. Two cascaded sources, excited with a single pulse, showed enhanced forward μ wave intensity as well as an angular dependence consistent with the double sources and single detector geometry. Finally, cooling from room temperature to 150K resulted in approximately a thirty percent improvement in μ wave strength (from a single source element).

OPTICAL STUDIES OF TWO NOVEL ELECTRO-EXPLOSIVE DEVICES

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Randolph-Macon Woman's College

Abstract

High speed streak photography and time integrated spectroscopy were used to characterize optical emissions from plasmas formed by two novel electro-explosive devices; a semiconductor bridge (SCB), and a semiconductor junction igniter (SJI). The spatial extent and expansion velocity of each plasma were determined as a function of time. An estimation of ion/neutral temperature was made by assuming that the identity of the ion/neutral was known and that the plasma was expanding freely in the plane parallel to the plane of the device. Time integrated spectra of the plasmas were complex and analysis is not complete at this time.

TECHNIQUES FOR DETERMINING THE PRECISION OF RELIABILITY PREDICTIONS AND ASSESSMENTS

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Abstract

A preliminary investigation of the various techniques available for determining the accuracy of reliability predictions was undertaken. The research project was designed as a complementary effort in support of the "New System Reliability Assessment Methods" program sponsored by Rome Laboratory N.Y. Classical statistical techniques used in probability theories were explored. The applicability of alternative approaches using possibility theory was investigated. Also the development of practical user-friendly reliability assessment techniques was studied.

STUDIES OF IONOSPHERIC ELECTRON CONTENTS AND HIGH-FREQUENCY RADIO PROPAGATION

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Abstract

The research involves temporal and spatial variations of the ionosphere and the overlying protonosphere and their effects on radio systems. Total electron content affects the time delays of transionospheric radio signals and, therefore, is important in navigation and positioning satellite systems. Several topics have been started that will be continued by future co-operation. Single frequency Global Positioning System (GPS) receivers require corrections for time delays in the ionosphere and the protonosphere. Ionospheric models, such as the USAF's Parameterized Ionospheric Model (PIM), allow predictions of ionospheric delays but the effect of the protonosphere is usually ignored. The main source of information on the protonospheric content is the ATS-6 Radio Beacon Experiment and these results are surveyed and compared with outputs of a current protonospheric model based on physical principles. In another project the ionospheric electron contents from PIM are compared with Faraday contents measured at Hamilton MA over the years 1967 to 1995.

The GPS provides an important new tool for the investigation of ionosphere structure and some uses of GPS in measurements of : total electron contents, electron density profiles, and ionospheric restraints on the measurement of tropospheric water vapor are discussed. The construction of TEC regional maps over Central Europe illustrates the potential of GPS in ionospheric applications.

The ionosphere profoundly affects the propagation of high frequency (3-30 Mz) radio signals. Propagation models are available that give information on optimum operating frequencies and signal strengths provided by a given transmiting system (including given output power, antenna characteristics, modulation, etc.) It is planned to use the USAF PRISM model as part of a real-time upgrade for short-term forecasting of HF propagation conditions. Discussions have been held on possible display formats for use by radio operators with the user friendly HF Propagation Resource Manager (PROPMAN) develpoed by Rockwell.

PERCEPTUAL ISSUES IN VIRTUAL ENVIRONMENTS AND OTHER SIMULATED DISPLAYS

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Abstract

Virtual environments are multisensory and highly interactive display systems that come in a myriad of flavors and varieties. These VE systems can serve a multitude of purposes within the scientific, medical, military, industrial, and entertainment fields in ways that more traditional human-computer interfaces simply cannot. Because of all the potential and actual uses for VE systems, developing an optimal VE system is a high priority.

Developing an optimal VE system requires knowing and capitalizing on the capabilities and limitations of human perception, both within a given sensory modality and integrated across sensory modalities. Yet, no available VE system can fully exploit the capabilities of human perception, especially those of human vision. These technological limitations can impose some perceptual tradeoffs in utilizing available VE systems that one must carefully consider.

Conversely, VE systems provide an opportunity to answer some fundamental questions about how humans build up percepts about what is out there and what is going on, both within a given sensory modality (e.g., vision) and integrated across sensory modalities. Although VE systems ideally could mimic real-world experiences, they are not bound by the limitations of the real world (e.g., gravity and the laws of physics). Thus, perception in the simulated world of a VE system can dramatically differ from that in the real world. That is, VE systems allow us to test some limitations and capabilities of human perception in ways that more traditional displays and the real environment do not.

Our challenges this summer were to tackle these issues by thinking and reading, by setting up and conducting some pilot studies to explore the formation of multistable percepts within a virtual environment, and by writing a draft of a review paper based on these ruminations and preliminary results.

Judith Dayhoff

Dynamic Neural Networks: Prediction of an Air Jet Flowfield

Abstract

A neural network with time-delay elements has been used to analyze and predict the dynamic structure of an air jet flow. A jet flow of hot air was produced in the laboratory, and measured at multiple downstream positions to determine the amount of optical refraction produced at the interface between the hot air flow and the surrounding cooler air ([MVF95] [MMC+95]. A series of measurements were taken over time, at varying distances from the jet flow. Using this data, we have trained neural networks to perform time-series analysis prediction on each data signal. The neural networks contained time-delay elements on their input signal as well as time-delay elements on multiple interconnections between each pair of neurons in the network. The networks had a feed-forward architecture, and were capable of training their weights and time- delays through a gradient descent approach. These networks, called time-delay neural networks (TDNNs) and adaptive time-delay neural networks (ATNNs), have been previously shown to be able to predict limit cycle oscillations and chaotic oscillations ([LDL94], [LDL95]). A network was trained successfully on each data signal recorded. The average performance of the neural networks was high, as they usually predicted 80 % to 93 % of the variation in the signals. The data appeared irregular, with no discernable pattern by eye. Predictions were performed on a one-step-ahead basis, and future studies are planned to expand this work to a prediction of two to five steps ahead, and to the analysis of longer data signals. Further research is underway to more fully develop and exploit the computational abilities of dynamic neural networks.

August 1996

GRAIN SIZE EFFECTS IN THE DETERMINATION OF X-RAY POLE FIGURES AND ORIENTATION DISTRIBUTION FUNCTIONS

by:
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Abstract

The production of metallic materials with controlled degrees of anisotropy is important because the controlled texture provides significant assurance that subsequent plastic deformation can be performed successfully and reproducibly. To proceed to this condition, the degree of anisotropy must be quantified by the experimental determination of x-ray pole figures and the orientation distribution functions (ODF) calculated from the pole figure data. To insure the intensity data collected is reliable the grain size of the specimen must be suitably small. The objective of this research was to determine the grain size error in measurement of pole figures on the x-ray diffractometer at Eglin AFB.

Analysis of Complex Cavities Using
The Finite Difference Time Domain Method

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Abstract

The Finite Difference Time Domain method has been used to analyze a Celestron 8 telescope and a satellite sensor. The specific program used, TEMAC3D (Temporal ElectroMagnetic Analysis Code), was written by John H. Beggs of Mississippi State University. TEMAC3D along with its graphical user interface, XTEAR (X-window Temporal Electromagnetic Analysis and Response), was ported to an IBM RS6000 at the University of Denver. Other supporting software, TSAR (Temporal Scattering And Response) from Lawrence Livermore National Laboratory and BRL-CAD, a computer aided design package from Ballistic Research Laboratory resided on SUN Workstations at the Satellite Assessment Center at Phillips Laboratory, Kirtland AFB, NM. BRL-CAD and TSAR are currently in the process of being ported to the IBM RS6000.

The Celestron-8 telescope was modeled as an antenna and as a scatterer. TEMAC3D results for the antenna model (aperture field and radiation plots) compare favorably to previous studies ([2] and [3]) using the Finite Element Method. Another sensor was modeled and time domain response at specific locations within the sensor were determined. The time domain information was Fast Fourier Transformed to the frequency domain to determine frequency response of the sensor. Due to a problem with possible instability of TEMAC3D for this model, future studies will investigate using a larger number of pad cells and adding a realistic finite conductivity to the Germanium lens and filters. The inverse problem (the radiation problem) will then by done to determine sensitive angles of incidence.

EVALUATION OF ENGINE-RELATED FACTORS INFLUENCING CONTRAIL PREDICTION

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Abstract

Forecasting the probability of contrail formation has been a long-standing problem for the United States Air Force. The theory applicable to contrail formation continues to develop as more observations become available. A critical factor in contrail formation is the ratio of water to heat in the exhaust from aircraft engines. In the 1950's, as the first formal theoretical descriptions of contrail formation by gas turbine-powered aircraft were developed by Air Force meteorologists, this ratio was taken to be determined solely by the properties of the fuel. Reasonable results were obtained when applying this theory to forecast where contrail formation would be expected. In recent years, as more efficient medium- and high-bypass engines have been added to the Air Force inventory, it is apparent that the ratio of water to heat in the engine exhaust plume, at the point in the plume where contrails initially condense depends on other factors. These include non-steady state engine settings, variations in fuel properties, extraction of accessory bleed air, bypass ratio, and propulsion efficiency. Variations in contrail factor of up to ~50% from a standard fuel-derived value are possible, leading to changes in contrail onset temperature of up to 5°C for a given environment in which onset temperatures are near -50°C.

INVESTIGATION OF PHOTOLUMINESCENCE INTENSITY SATURATION AND DECAY, AND NONLINEAR OPTICAL DEVICES IN SEMICONDUCTOR STRUCTURES

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Abstract

We have observed saturation of photoluminescence peak at low pump intensities in growth-interrupted asymmetric-coupled quantum-well structure. We believe the saturation is due to filling of the exciton states localized at the interface islands. We have observed increase of the photoluminescence decay time as pump intensity increases in the same structure.

Based on our design, a new multilayer structure was grown for demonstrating transversely-pumped counter-propagating optical parametric oscillation and amplification, and achieving surface-emitting sum-frequency generation in a vertical cavity.

We have attempted to mode-lock Ti:Sapphire laser pumped by an Argon laser. We conclude that stability of the Argon laser is crucial for achieving stable mode-locking.

STUDIES OF ION-MOLECULE REACTION RATES AT VERY HIGH TEMPERATURES

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Abstract

Rate coefficients for a few ion-molecule reactions have been measured in the range 300-1800K. The measurements were carried out in a flowing afterglow apparatus designed for the measurement of ion-molecule reaction rate coefficients at temperatures higher than any previous measurement. Reactions measured were $N_2^+ + O_2$, $O^+ + O_2$, $O^+ + N_2$ The results are compared with previous studies of temperature and transitional energy dependencies of ion-molecule reaction rate coefficients. Preliminary results were obtained for the reaction $O^+ + NO$. Experimental problems relating to operation of a flowing afterglow apparatus at high temperatures were solved and discussed.

THE ANALYSIS OF *PROFILER* FOR MODELING THE DIFFUSION OF ALUMINUM-COPPER ON A SILICON SUBSTRATE

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Department of Physics
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Abstract

A detailed analysis of ***PROFILER***, a computer program that predicts the interdiffusion of an alloying couple, has been completed, and its application to the diffusion of copper into aluminum has been initiated. ***PROFILER*** has been observed to model the concentration profiles of up to eight diffusants in the alloying couple. Also, the program provided its results quickly, within a matter of seconds. While its applicability to Aluminum-Copper thin films remains to be established, such as effort within itself would be viable and should be completed. These considerations, on diffusion, were a part of a larger effort, the systematic prevention of electromigration, which occured from electrical current-induced movement (diffusion) of metallic atoms. The analysis of ***PROFILER,*** as provided by thermal stressing of the sample, and its preliminary application to an Aluminum-Copper thin film on a silicon substrate are reported as an effort to understand and control electromigration.

AVIATION FUEL IDENTIFICATION

PART I.
NEURAL NETWORK ANALYSIS
OF THE
CONCENTRATION OF BENZENE AND NAPHTHALENE DERIVATIVES
IN FUELS

PART II.
THE RESPONSE OF AN ARRAY OF
VAPOR SENSITIVE DETECTORS
TO
WEATHERED FUELS

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Abstract

Part I

The concentration of ten benzene and naphthalene derivatives was determined in one hundred and two (102) aviation fuels using gas chromatography/mass spectrometry (GC/MS). Artificial neural network analysis techniques were then used to classify the fuels from the resultant data matrix. Ultimately only six compounds were required to make the classification.

Part II

A preliminary study was done comparing the response of an array of vapor sensitive detectors to *fresh* and *weathered* JP-4, JP-5, JP-8, JPTS and JetA aviation fuels. The fuels were *weathered* by allowing them to evaporate in a hood for two weeks. The response of the array was essentially the same for *weathered* and *fresh* samples of the same fuel. These results must be confirmed in a more complete study. However, if this is correct, the response of such an array could be used to identify samples of aviation fuels **almost independent of the age of the sample.**

LASER BASED DIAGNOSTIC TECHNIQUES FOR COMBUSTION AND COMPRESSIBLE FLOWS

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Abstract

Laser based diagnostic techniques were used and developed in the study of combustion and compressible flows. Laser diagnostic techniques based on using molecular filters to discriminate the Rayleigh scattering from molecules or particles in a flow field were investigated. The first technique termed filtered Rayleigh scattering was used to measure the instantaneous temperature field in hydrogen-air and methane-air flames. Uncertainties in these measurements were explored and found to be from 4 to 7% for the product region of the flame, but slightly higher (approximately 16%) in the reaction region of the flames studied. This uncertainty was primarily associated with the unknown species concentration and possible solutions to this problem will be investigated. A second molecular filter based technique called filter planar velocimetry (FPV) allows the measurement of the instantaneous velocity in a two dimensional plane. FPV was used to investigate axisymmetric and elliptic jets in a $M = 2$ cross flow. To date preliminary average measurements have been analyzed and are presented here. Lastly, flow visualizations were taken of underexpanded square jets to investigate the flow structure and use as a possible mixing enhancement configuration.

ON THE MATERIALS SELECTION OF DURABLE COATINGS FOR CRYOGENIC ENGINE TECHNOLOGY

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Abstract

Many benefits can be realized by incorporating hydrostatic bearings into liquid hydrogen turbopumps, however, suitable material coatings must be used to avoid excessive wear during multiple starts and stops. A short list of eight coating materials is suggested. Nine manufacturers out of fifty contacted are identified as capable of depositing durable coatings on Inconel 718. A cost effective low temperature tribometer based on the hydrostatic bearing application should be designed and built prior to performing full scale tests in area I-14.

VERTICAL 3-D INTERCONNECTS FOR MULTICHIP MODULES

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and Computer Science Department
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Abstract

In this report, a vertically-connected 3D T/R module for a conformal phased array antenna systems is investigated. Active and passive elements and circuits suitable for the proposed 3/D modules are analyzed. The module involves the use of thermally shunted HBT for power amplifier, various distributed circuit elements realized by coplanar waveguides (CPW), and vertical posts interconnecting the various circuit layers. Coplanar waveguides completely immersed in a dielectric medium and surrounded by an upper and a lower ground plane is analyzed using conformal mapping. It is shown that if the separation distance between the side ground planes of the CPW is small compared to the vertical distances to the upper and lower ground planes, the impedance of the line becomes independent of the dielectric layer thickness. Sycar is chosen as the dielectric material. Uniformity and thickness control during the processing of sycar will lead to reliable low loss vertical interconnects. The goal of the project is to implement a 3D T/R module and demonstrate the feasibility of 3D vertical interconnects by incorporating these modules in a 2x2 phased array antenna system.

KINETIC STUDIES OF THE THERMAL DECOMPOSITION OF DEMNUM AND X-1P USING THE SYSTEM FOR THERMAL DIAGNOSTIC STUDIES (STDS)

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Abstract

The System for Thermal Diagnostic Studies (STDS) links a thermal reactor cell directly to a GC/MS for the examination of gas phase behavior of materials as a function of temperature, time, and atmosphere. Demnum, a perfluoropolyalkyl ether, has been studied as a high temperature lubricant while X-1P, a cyclotriphosphazene, has shown potential as a vapor phase lubricant. The decomposition of Demnum S-65 was studied in the temperature range of 300°C to 750°C and X-1P was studied between 300°C and 625°C. Rate constants for the decomposition were determined for each substance.

A STATISTICAL PROCESS CONTROL SUCCESSFUL APPLICATION: DESIGN, IMPLEMENTATION, AND PROCESS IMPROVEMENT IN SEVERAL AREAS AT A CLOSING BASE

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Abstract

The repair/refurbish/remanufacture environment of the repair depot at Kelly Air Force Base is a non-traditional manufacturing operation aimed at the maintenance of the Air Force's aircraft. Since maintenance of used aircraft entails the disassembly of the aircraft and components of the aircraft, inspection of the parts for wear replacement or repair, refurbishment and reassembly, testing, and return to the users, the variability of the functions necessary to repair the aircraft is high. With small lot sizes, high variability of the work load, and long cycle times, traditional use of statistical process control is very difficult or inappropriate. The assessment of statistical process control in this unique manufacturing environment was the aim of this project.

The use of Statistical Process Control in the San Antonio Air Logistics Center was investigated as to the present use of the discipline as of the summer of 1995. The summer of 1996 was an extension of that effort with the additions of two more area in one Directorate and another area within an additional Directorate.

Results are presented for the original Statistical Process Control study on-going until the present. The results of that study are quantified and analyzed. Personnel response to the study are added. The new areas that were analyzed with this year's study have data presented. Conclusions and recommendations are included.

TESTING THE FROZEN SCREEN MODEL OF ATMOSHPERIC TURBULENCE AND AN INTERFEROMETER DESIGN FOR MEASURING ATMOSPHERIC TURBULENCE NEAR GROUND LEVELS

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Abstract

Atmospheric turbulence is responsible for scattering of the light that makes it's way through the atmosphere and therefore deteriorates the observations being made by any astronomical instrument. This study designs a triple coincidence experiment to test the frozen screen model of atmospheric turbulence and determine if we can put in place an interferometer or equivalent system that will measure the atmospheric turbulence in the near field. Various types of interferometers have been considered including the Fabry - Perot and the Mach - Zehnder arrangements. Other design considerations include the path lengths necessary for detection of small changes in the index of refraction of air, light sources and positioning of the interferometer.

The "frozen" screen model is to be tested to determine if it can be used as a predictive tool. If the turbulent disturbances travel as a frozen screen it should be possible to sample them upstream of a telescope and apply corrections in real time; or if this is not possible then downstream of the telescope for post detection corrections. We propose to build an 'Amato' (one arm in vacuum) Mach-Zehnder type interferometer with physically coupled arms that expand and contract together to null any pathlength changes in the system due to changes in the apparatus. This is to insure that all phase shifts in the fringe pattern are due to changes in the index of refraction of the air in the open arm, see section *. We propose to use two identical setups in an upwind/downwind configuration and check for time delayed coincidences in the fringe patterns. In parallel we propose to run a very high resolution Fabry-Perot Interferometer and very sensitive Microbarograph and do similar coincidence studies to see if any or all methods are useful in detecting and predicting atmospheric fluctuations.

NOVEL APPROACH FOR THE COMPRESSIVE STRENGTH IMPROVEMENT OF RIGID ROD POLYMERS

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Abstract

Rigid rod polymers like PBZT, PBZO and PBZI are known for their excellent thermal stability, high modulus and high strength. However, one of the major drawback of these polymers is their low compressive strength. To overcome this problem a novel approach was taken and the new monomer was synthesized. This monomer was synthesized by reacting 4,4'-dibromo-2,2'-bis(4-methylbenzoxazolyl)biphenyl with 2-amino-p-cresol in PPSE, o-DCB mixture at an elevated temperature. The bromide functionality was subsequently replaced by cyano group and then hydrolysed to the carboxylic acid. Computer simulation on this monomer has indicated the non-planar geometry. The bulkiness and the thermal stability of the side group is indicative of the non planarity of the biphenyl rings in thermally treated polymers. This will result in 3-D cross-linked polymer of high compressive strength.

A COMPUTER MODEL FOR SUSTAINABILITY RANKING

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Abstract

A computer model is developed and implemented to compute sustainability ranking number for national stock numbers. The ranking depends on a set of critical variables spanning a multidimensional space. Values of the variables are obtained from different databases. Principal Component Analysis is used to reduce the data dimension to one. The ranking is obtained as a linear combination of the original variables. A computer program has been implemented to obtain values from the relevant databases and to compute ranking. This program accesses the databases, computes the ranking, and produces a table. The program is implemented as an embedded dynamic SQL program using C. The sustainability ranking computed by the program is expected to assist Air Force weapon systems managers in their decision making process.

A STUDY OF OXIDATIVE REACTIONS MEDIATED BY LASER-EXCITED OCULAR MELANIN

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Abstract

Melanin is excited to a free radical when exposed to visible light. Normally, the reactivity of the melanin radical is contained by the melanosome complex. After laser injury to ocular tissue, however, the possibility exists that melanin in damaged melanosomes of the retinal pigment epithelium (RPE) could react with physiological substrates to produce photochemical damage in surrounding tissue. The ability of the melanin radical to oxidize nicotinamide adenine dinucleotide phosphate (NADPH) during light exposure was used to characterize the reactivity of RPE melanosomes after various experimental treatments. Melanosomes disrupted by the fundamental output of the Nd:YAG laser oxidized significantly more NADPH than did intact ones during subsequent exposure to a visible light source. As the sample irradiance produced by the YAG laser exposure went up, melanosome photoreactivity increased. The rate of increase was used to estimate that the threshold for melanosome disruption by a 10 nsec pulse at 1064 nm was about 560 mJ/cm^2. Based on the amount of NADPH oxidized by melanosomes excited by various laser wavelengths, the action spectrum of the melanin radical has a broad peak in the visible spectrum between 450 and 500 nm. The melanin radical was also detected with two fluorescent probes sensitive to oxidation, 2',7'-dichlorofluorescin (DCFH) and dihydrorhodamine 123 (DHR123). Both probes showed a progressive increase in fluorescence when mixed with RPE melanosomes and excited with the 496 nm line from an Argon ion laser. The growth in the fluorescence signal increased with the number of melanosomes in the reaction mixture, laser excitation power, and prior photodisruption of the melanosomes. Addition of ascorbic acid, an aantioxidant, quenched the fluorescence. DHR123 was less sensitive to AA quenching than was DCFH, possibly indicating a lower oxidation potential than that of AA. The ability of these fluorescent probes to detect melanin radical activation may be useful in investigating mechanisms of tissue damage in the retina and RPE following short pulse laser exposures.

DEVELOPMENT OF A PHYSIOLOGICALLY-BASED PHARMACOKINETIC MODEL FOR THE UPTAKE OF VOLATILE CHEMICALS DURING A SHORT TIME INTERVAL: PRELIMINARY STAGES OF MODEL DEVELOPMENT

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Abstract

The development of a physiologically-based pharmacokinetic model has been initiated to simulate the physiological uptake of halogenated hydrocarbon vapors from the lungs into the arterial blood and into the tissue compartments. This model will facilitate the investigation of health risks associated with the use of the halogenated hydrocarbons that are used as fire-fighting agents. Specifically, the chemical uptake during a five-minute exposure to halothane is investigated. Also the modeling is extended to include the uptake of other volatile chemicals.

The emphasis of the research involves the preliminary stages in the development of the mathematical model. The applications of the mass-balance principles used for the development of the model is introduced. The underlying assumptions are examined. A brief research literature review is presented. Criteria for characterization of the compartmental time scales are presented. Alternative non-linear models are described and evaluated. The role of the concentration effect and the second gas effect upon alveolar uptake is reviewed. The effects of the absorption of chemicals upon the surfaces of the conducting airways is discussed along with the applications of numerical fluid dynamic methods for the quantification of these effects..

SPEAKER IDENTIFICATION AND ANALYSIS OF STRESSED SPEECH

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Abstract

In the first part of this project, feature extraction using Fourier and Fourier-Bessel (FB) transforms was carried out for the purpose of text-independent speaker identification. It was found that for speech transmissions from aircraft, a combination of 20 cepstral coeffcients on linear and mel frequency scale yielded an identification score of 80 %. A slightly lower score of 76 % resulted when the features were formed using log spectral energies in 20 bands of overlapping frequencies. Identification scores of 74 % and 76 % were achieved using a set of 15 and 20 features based on the expansion of the speech signals in the FB transform. Due to the highly noisy nature and the short segments of the test data base, feature vectors obtained from the linear predictive representation of speech, however, yielded poor identification scores of below 55 %. The scores in each case were obtained with a single set of features using the same commercial classifier that was based on vector quantization of features. The single-feature based results achieved in this project compare favorably with the results obtained on the same speech data base using methods of feature and/or classifier fusion at Rome Laboratory.

The same set of features based on Fourier and FB transforms were studied for the identification of speakers using a second group of nine speakers. The utterances for this group consisted of aircraft-to- ground transmissions of speech by nine pilots who were considered under stress. With 1054 test utterances, scores of 88 % and 84 % resulted using 20 cepstral coefficients and 20 log spectral energies respectively. Using FB transform-based features, the scores achieved were 65 % with the energy parameters and 62 % with the frame difference of the energy parameters.

Based on the identification scores using cepstral and FB transforms, a study of the analysis of speech under stressed conditions was begun in the second part this project. The initial results using the FB transform appear to show variations of features with variations in the stress level of the speaker under mayday conditions. Further processing using FB transforms is expected to better bring out the acoustical correlates of speech under stress.

A FRAMEWORK FOR MANUFACTURING-ORIENTED, DESIGN-DIRECTED COST ESTIMATION

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ABSTRACT

Defense system requirements have shifted from performance at all costs, to one of ensuring superiority, yet being affordable. As a result, affordability has become the primary focus of weapon system procurement. In order to develop affordable products, product design and manufacturing process design must be considered concurrently and early in the design phase. One approach to developing affordable systems is to combine the integrated product/process development (IPPD) process and virtual manufacturing (VM), or "manufacture in the computer." However, if product and process design issues are to be effectively considered, then cost, schedule, and risk assessment tools must be sensitive to changes in the product's physical design as well as to changes in the manufacturing system. Unfortunately, such tools are not available today. However, this deficiency provides an opportunity to totally rethink or "re-engineer/re-design" manufacturing cost estimating methodologies.

But, before "designing" and developing cost estimating methodologies that adequately address affordability issues, effectively support the IPPD process, relate product and process variables, operate in a virtual design environment, and model manufacturing and non-manufacturing indirect activities, the progression of modeling, analysis and costing – from the individual features of the product being designed to its impact on the enterprise – needs to be understood. This research provides a framework that defines the modeling and analysis progression from product features to an enterprise view of the production of the product. The framework provides the foundation for manufacturing-oriented, design-directed cost estimating (MODDCE).

AFFECTS OF INTERNATIONAL QUALITY STANDARDS ON BARE BASE WASTE DISPOSAL ALTERNATIVES

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Abstract

This research was sponsored by the Air Force Office of Scientific Research, Bolling AFB, DC and the Air Force Wright Laboratory Air Base Technology Branch (WL/FIVC-OL Tyndall AFB, FL) as part of the Summer Faculty Research Program. This research was designed to assist Wright Laboratory Air Base Technology Branch in identifying emerging technologies for the development of a versatile, air mobile, and environmentally safe waste processing system to support force deployment operations. In addition, a specific thrust of this researcher is to develop cost/benefit methodologies and to incorporate in the alternative development processes those aspects of engineering, socio-economic, and policy issues that could impact the cost effectiveness of alternative solutions. This final report discusses some of the issues that International Quality Standards could have on the design and cost effectiveness of Bare Base Waste Disposal Alternatives. Although these standards are still under development and there are not yet definitive policies (14, 15) on how the DoD will integrate these standards into their bare base deployments, a DoD wide Environmental Management Systems Committee has been formed. (14, 15) They will continue to evaluate the development of international standards to determine if they present an "opportunity for DoD to improve its environmental management," with a "primary motivation for (sic) regulatory relief and reduced costs." (14) This researcher believes these standards will require us to process waste more efficiently and environmentally sound, thereby provide solid ground to support technology innovation under development and proposed by Wright Laboratories.

MISMATCH STRESSES, LAMELLAR MICROSTRUCTURE AND MECHANICAL PROPERTIES OF TiAl-ALLOYS

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Abstract

The elastic misfit stresses in TiAl alloys assume huge level of the order of the product of the elastic moduli times misfit deformations. The elastic energy associated with these stresses is enormously large also and it tries to relax via one of several possible mechanisms. Hence, there appears a driving force for the rearrangement of the material elements leading to the evolution accompanied by the creation of dislocations, migration of vacancies, development of interfacial corrugations, etc...

The goal of this research project is two-fold: i)to develop a theoretical approach which permits a self-consistence calculations of misfit stresses in TiAl lamellar multilayers and like structures, and ii)to develop a thermodynamic approach allowing one to study the possibility of stress relaxation by means of mass rearrangement in the vicinity of the interface between the lamellae. We assume that the rearrangement is accompanied by interfacial diffusion and migration of the vacancies. Since the full consideration of the coherent interface solid-solid includes lots of calculation and details we illustrate our results and approach by considering the much simpler but conceptually a very close problem of mass rearrangement in the vicinity of a stress-free interface.

ULTRAWIDE-BAND MICROWAVE EFFECTS TESTING ON AN ELECTRONIC SYSTEM

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Abstract

Two ultrawide-band, high power microwave sources have been used to study the susceptibility of a particular electronic system to functional upset during irradiation. Both sources provided pulses with sub-nanosecond widths. Three distinct values of the peak electric field were achieved using the two sources; the peak field amplitudes at the test object scaled in the ratios 100:71:17. Pulse repetition frequencies were varied from 100 Hz to 60 kHz. The system under test demonstrated susceptibilities within this range of field amplitudes and pulse repetition frequencies, but reproducibility was poor. It appears that the poor reproducibility can be ascribed to differing conditions within the system under test at different points in time. In spite of the scatter in the test data, the general trend of the results will provide important insight into the response of the test system under ultrawide band microwave irradiation.

INLET DISTORTION TEST CONSIDERATIONS FOR HIGH CYCLE FATIGUE IN GAS TURBINE ENGINES

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Abstract

Requirements for lower life cycle cost for the next generation of USAF aircraft will dictate more compact inlet designs because of the lack of length for inlet flow distortion decay. It is imperative that tests reproduce the actual flow conditions at the engine interface plane. This report discusses inlet distortion test considerations for high cycle fatigue in gas turbine engines, and outlines the limitations of current screen tests to simulate the proper levels of turbulence and swirl in the induction system.

A VOLUMETRIC EIGENMODE EXPANSION METHOD FOR DIELECTRIC BODIES

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Abstract

The work reported here relates to the electromagnetic characterization of a general dielectric target. The motivation for the problem is the detection and identification of a buried dielectric mine. An eigenmode expansion method (EEM) is developed for dielectric bodies residing completely within a homogeneous region of a generally inhomogeneous medium. The representation follows naturally from the EEM method previously developed for perfectly conducting bodies, including those with impedance loading. For the latter class of objects, the presence of loading shifts the eigenvalues from those of the unloaded case, but leaves the eigenmodes unchanged. It is observed from the governing integral equations that the dielectric body can be considered as a loading of the background space. As such, eigenmodes of homogeneous isotropic bodies are found to be independent of the material comprising the body, with eigenvalues dependent upon the material's characteristics in a simple fashion. Formulation of the eigenvalue problem is described for general dielectric bodies, and the EEM is applied to an infinite slab problem to demonstrate the method.

The EEM provides information concerning the effect of the external environment on the electromagnetic behavior of a dielectric target, and characterizes a target by a means which is independent of the material comprising the target. This may facilitate the development of detection technologies based on an object's singularity characteristics. Another, related project concerning the resonances of dielectric targets was also completed during the AFOSR Summer Faculty Research Program period. Due to space limitations, the results of that project are not included here, but may be found in Interaction Note 520[1].

[1]G.W. Hanson and C.E. Baum, "Perturbation Formula for the Internal Resonances of a Dielectric Object Embedded in a Low-Impedance Medium," Interaction Note 520 (Phillips Laboratory Note Series, Kirtland AFB), Aug. 1996.

COMPOSITIONAL MODULATION DURING EPITAXIAL GROWTH OF SOME III-V HETEROSTRUCTURES

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Abstract

Analytical models describing the vertical transfer reaction that occurs during the epitaxial growth of certain III-V alloys were formulated and solutions for the mole fractions of the metal components as a function of the layer thickness obtained. These results support recent simulation studies which indicate the occurance of compositional modulation in the high temperature MBE growth of (Al,Ga)As. Since this has not yet been experimentally verified, the most detailed model that we considered was for the growth of (In,Ga)As where our model provides a more accurate description of the transfer reaction and a better interpretation of the experimental results than the only previous treatment.

Mode-locked Laser Models and Simulations

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Abstract

Models for mode-locked lasers were developed and computer simulations of the models were made. The lasers we examined operate in the 1.5 μm wavelength regime, which is of interest for C3I applications. I was especially interested in the characteristics of three lasers at the Photonics Center of Rome Laboratories: the Cr^{4+}:YAG laser, the harmonic mode-locked fiber laser and the passive, semiconductor mode-locked fiber laser. The Cr^{4+}:YAG laser model has been successfully modeled with results that help understand the experimental laser conditions. Modeling is continuing with the other two laser designs.

One papers was prepared for publication and a second is being planned, based on experiments with mode-locked fiber lasers. Conference papers were delivered at the Optical Society of America Conference and an Air Force workshop in Tucson, AR. An abstract was submitted to the Optical Fiber Conference, which will be held in February, 1997.

EFFECT OF HUMIDITY ON WEAR OF M-50 STEEL WITH A KRYTOX LUBRICANT

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Abstract

Using a Cameron-Plint tribometer under controlled environmental conditions, wear of M-50 steel with a Krytox (a branched perfluoropolyalkyl ether) lubricant was studied under boundary lubrication conditions at 150°C in air with relative humidity ranging from 1% to 95%. Both wear and friction decrease sharply as humidity is increased from 1 to 20%, then are constant as humidity increases to 95%. Thus, wear is highly dependent on humidity when relative humidity is less than 20%. The similar effect of humidity on wear previously observed for Fomblin Z, a linear perfluoropolyalkyl ether containing difluoroacetal groups, and Demnum S, a linear perfluoropolyalkylether which does not contain difluoroacetal groups, indicates that this may be a general property of all commercially available perfluoropolyalkylethers.

HYPERBARIC OXYGEN EFFECTS ON THE POSTISCHEMIC BRAIN

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Abstract

Hyperbaric oxygen therapy has been previously studied as a method of accelerating wound healing, and is used medically in the treatment of carbon monoxide poisoning, nitrogen embolism, and burn trauma. Hyperbaric oxygen therapy has been suggested as a method for counteracting some aspects of ischemia / reperfusion pathophysiology, by augmenting tissue oxygenation or by other mechanisms. In this study, an animal model of ischemia / reperfusion was employed to assess the effects of hyperbaric oxygenation on biomarkers of tissue damage in the postischemic brain. Mongolian gerbils were surgically implanted with carotid loops, which could be drawn tight to induce a defined period of near-total cerebral ischemia. Animals were exposed to two atmospheres of 100% oxygen for one hour prior to, or following ischemia. Animals were killed at time points after the experimentally induced ischemia / reperfusion, and organs archived for latter analysis. Initial results indicate that hyperbaric oxygen treatment does not counteract ischemia-induced decrease in brain glutamine synthetase activity, which has been repeatedly shown to index brain pathology in animal models of ischemia / reperfusion. To the contrary, in the current study, hyperbaric treatment following ischemia / reperfusion significantly exacerbated ischemia-induced loss of glutamine synthetase activity in the gerbil hippocampus as assayed in tissue removed 24 hours following the ischemic event. Furthermore, animals receiving the experimental ischemic insult demonstrated significantly increased hippocampal creatine kinase activities 24 hours after reperfusion, whereas animals receiving hyperbaric oxygenation (either before or after ischemia / reperfusion) failed to demonstrate this CK response.

INVESTIGATION OF THE SUITABILITY OF TACTILE AND AUDITORY STIMULI FOR USE IN BRAIN ACTUATED CONTROL

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Abstract

Brain actuated control, BAC, has been demonstrated to be possible utilizing an oscillating visual stimulus, acting like a carrier signal, which is modulated by thought processes and detectable in the EEG of a trained subject. This modulated EEG signal has been used to control a variety of physical devices. Among other applications, this type of "hands off" control could be eminently applicable to the assistance of people with disabilities to let them control their environment. The visual stimulus required, however, may not be appropriate for use out of a well controlled space. For this study we investigated alternate stimuli to evaluate their possible use in a similar BAC operating mode. Tactile and auditory stimuli were used at the same fundamental frequency as the visual stimulus, 13.25 Hz, and also at a higher frequency, 43 Hz. The specific goals were to successfully detect the stimulus carrier in the EEG signal as a steady state evoked response, and to determine best locations for electrodes.

Results of the study show that stimulation by both auditory and tactile means generated evoked responses that were of useable amplitude. Fundamental frequency components as well as some second and third harmonics were observed. Power spectral levels of the fundamental were routinely 5 or 6 dB above the local baseline for the auditory and tactile stimuli. In certain cases as much as 9 dB can be demonstrated. As a comparison, the visual stimulus results in typical fundamental frequency power spectral levels of 12 to 14 dB above baseline. Of the electrode sites investigated, electrodes giving a differential between f4 and p3 were consistently the best in this study. The positive results of this study indicate that future development of these alternative stimulus modes for BAC would have a high probability of success.

VOC Emission Control by A Gas Turbine Combustion System
-Economic and Technical Evaluations

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Abstract

On July 31, 1995, the Aerospace NESHAP was officially released and was officially published on Sept. 1, 1995. The rule is that the industry has to either use compliant coatings or use a compliant facility that can reduce the VOC emissions by 81% by Sept. 1, 1998. This implies that by Sept. 1, 1998, not a single plane can be painted unless the hangar meets the definition of a compliant facility or other coating techniques that emit VOCs less than the NESHAP standards are employed. It is then urgent that the industry find a cost effective way to solve this problem.

The traditional and commercially available emission control technologies for VOCs include process modification, solvent reformulations, and add-on control systems that incinerate or trap the VOCs. When cost effective process and solvent changes are not available, more costly add-on controls are the only alternative. These systems can be a significant economic burden since the flow rate of the VOC-laden air stream can be quite large, and with the concentration of the VOCs being quite small, the economic value of recovering the VOC solvents is negligible.

This study concludes that:

1) Gas turbine cogeneration is the most effective and efficient VOC control technology since:

- it destroys the pollutants. Many other technologies, such as carbon adsorption, only transform the pollutants into other phases. To eliminate the pollutants, it takes additional energy to either recover or consume them.

- it generates power and steam in the process of destruction of VOCs. The other technologies use extra energy to destroy the VOCs.

- when combined with recirculation, the VOC concentration can be increased to further reduce the energy consumption by 15%.

- the initial capital cost is higher than the other technologies. However, the generated power and steam produce positive investment returns. Note that other technologies involve additional energy consumption and waste disposal, which can be as high as their installation costs. However, the capital cost is associated with energy production; the cost associated with VOC control is actually negative due to the contributed VOC heat value.

Wavelets and Their Applications to the Analysis of Meteorological Data

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ABSTRACT

The objective of this project was to apply wavelets and multiresolution analysis to stratospheric data in order to infer and extract the local turbulent structures. Local values for the Reynolds number and the spectrum of various meteorological variables has been obtained. Furthermore we devise an algorithm to construct and apply "data fitted wavelets" to detrend meteorological data.

FAULT ANALYSIS AND EXCITATION REQUIREMENTS FOR SWITCHED RELUCTANCE STARTER-GENERATORS

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Abstract

The excitation requirements with and without faults for switched reluctance starter/generators were studied in this research. The size of the excitation source required during the initial voltage build-up stage of generating mode and under fault conditions is a critical issue in aircraft starter/generator engines. In this research, simulation models were modified and further developed from existing models to simulate various switched reluctance starter/generator configurations. The models were used to investigate the fault modes and determine the excitation requirements of four different machine configurations.

The various fault modes in the External Integral Starter-Generator (EIS/G) were first analyzed, and the excitation requirements under these faulted conditions were simulated and studied. The load fault case presented the worst case scenario as far as the excitation requirements are concerned.

Three-phase machines with three-repetitions, and four-phase machines with two- and three-repetitions were designed using the same specifications as that of the EIS/G (three-phase, two-repetitions). Simulation showed that the excitation requirements for the four-phase machines were lower for initial voltage build-up, but more under similar load fault conditions compared to that of the three-phase designs.

The system level simulations including the faults were performed in Matlab-Simulink platform. Mathcad programs were used to design the machines.

DETERMINATION OF THE INFLUENCE OF ULTRAWIDEBAND EXPOSURE OF RATS DURING EARLY PREGNANCY ON PREGNANCY RATE, EMBRYONIC SURVIVAL TO TERM, AND SEX RATIO OF OFFSPRING

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Abstract

Several epidemiological surveys have detected statistically significant associations between health effects and residential and/or occupational exposures to electromagnetic fields. Field effects have been reported for exposures ranging from fields which approach DC fields, including extremely-low-frequency fields (<300 Hz), particularly those at 50 and 60 Hz, to high frequency radiation in the kHz to MHz ranges. A mechanism or mechanisms that would explain such effects have not been developed although some hypotheses have been formulated that could provide a biological basis to explain the observed outcomes. Among these reports, Larsen **et al.** (1991) found that occupational exposure of Danish physiotherapists to non-ionizing radiation was associated with alterations in gender ratio and birth weight of offspring. In an attempt to evaluate experimentally whether such an effect could be demonstrated, studies were initiated using a rat model. The UWB source used for this study was a microwave transmitter that was capable of generating electromagnetic pulses ranging from near DC to several GHz, but had, as a primary component, microwave pulses in the MHz range. Virgin female rats were paired with males of known fertility. Mated females were then randomly assigned to a sham-treatment or to an UWB-exposure group. Rats were exposed to the assigned treatment during the first 3 days of pregnancy. Females were then monitored for pregnancy, birth and survival of offspring, and sex distribution of the pups born. No effects of electromagnetic field exposure were seen for pregnancy rate, postimplantation embryonic survival, birth of live offspring, or gender ratio.

SHAPE CONTROL OF AN INFLATED THIN CIRCULAR DISK:
Preliminary Investigation

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Abstract

Space-based inflatable technology is of current interest to NASA and DOD, and in particular to the Air Force and Phillips Laboratory. Potentially large gains in lowering launch costs, through reductions in structure mass and volume, are driving this activity. Diverse groups are researching and developing this technology for radio and radar antennae, optical telescopes, and solar power and propulsion applications. Regardless of the use, one common requirement for successful application is the accuracy of the inflated surface shape. The work reported here concerns a preliminary nonlinear finite element analysis of shape control of an inflated thin circular disk. Shape modification was achieved through enforced boundary displacements, which resulted in moving the inflated shape towards a desired parabolic profile. Conclusions and future work activities are provided.

IN SITU FORMATION OF STANDARDS FOR THE DETERMINATION OF WEAR METALS IN PERFLUOROPOLYALKYLETHER LUBRICATING OILS

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Abstract

Methods have been developed for the in situ formation of metal standards for use in perfluoropolyalkylether based lubricants. The standards are prepared by dissolving a known mass of metal; either as the pure metal or as a metal salt in either the lubricant, containing 5% of a chelating ligand, or in a co-solvent which is used to decrease the viscosity of the lubricant before analysis. Appropriate ligands for perfluoropolyalkyl ether based lubricants include 2,2-dimethyl-6,6,7,7,8,8,8-heptafluoro-3,5-octanedione and 1,1,1-trifluoro-2,4-pentanedione. For non-fluorinated lubricants various other β diketones are useable.

ELECTROMAGNETIC WAVE TRANSFORMATION IN A TWO - DIMENSIONAL - SPACE - VARYING AND TIME - VARYING MAGNETOPLASMA MEDIUM

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Abstract

A magnetoplasma goes through a transient state due to various disturbances or stimulations that cause a temporal change in its parameters. Lightning induced effects in the ionosphere or the disturbances caused by the heating experiments are examples of such transient magnetoplasmas.

An electromagnetic wave is transformed in a remarkable way by a transient magnetoplasma. A new perspective on adiabatic analysis based on a slow change of the parameters is discussed.

The relevant field equations for the general case where the parameters of the magnetoplasma vary both in space and time are investigated. Yee's computational algorithm based on 'Finite Difference Time Domain method' is adapted to obtain numerical solution of these equations. Such a solution is useful in exploring new effects. It is also useful in validating the approximate analytical solutions of simpler physical models.

As a next step, the author of this report would like to (1) investigate the numerical stability, numerical dispersion and other numerical analysis aspects of the algorithm. (2) develop a code and investigate the effect of a transient magnetoplasma including the lightning induced effects in the ionosphere and the transformation of an electromagnetic wave during the ionospheric heating experiment.

ABSTRACT

Genetic algorithm (GA) is considered to be a robust technique for solving groundwater optimization problems. These problems are often nonconvex, nonlinear and discontinuous, and they are difficult to solve using traditional gradient-based techniques. In this study, a linear groundwater management problem is solved using GA. The global-optimal solution obtained using linear programming (LP) is known, and the LP solution is used to find the robustness of GA. The effect of ignoring infeasible solutions is studied, and a string-length defining method (SLDM) is outlined. Also, the problem is subjected to a sensitivity analysis and attempts have been made to standardize GA parameters. Finally, a general guideline for solving such problems using GA is suggested. The guideline reduces GA to the selection of population size only; the size refers to the number of trial solutions GA considers during a standard generation.

MODELING DECOMPRESSION SICKNESS USING SURVIVAL ANALYSIS TECHNIQUES

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Abstract

The application of survival analysis methods to modeling altitude decompression sickness was studied. Parametric Models were developed to assess the effect of several covariates on the probability of DCS. The model was used to predict the risk/ probability of DCS for several flight profiles. The goodness of fit of the model was examined using cross validation techniques. These models were adjusted to include data on bubble grade and times.

THICK SECTION CUTTING WITH CHEMICAL OXYGEN-IODINE LASER AND SCALING LAWS

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Abstract

Almost all laser-assisted materials processing involve melting, vaporization and plasma formation. These phenomena affect the utilization of laser energy for materials processing. To account for the effect of these phases, an effective absorptivity is defined, and a simple mathematical model is developed for thick-section stainless cutting with a high power Chemical Oxygen-Iodine Laser (COIL). The model is based on overall energy balance, and it relates the cutting depth with various process parameters that can be used to predict scaled laser materials processing performance to very thick sections. The effects of various process parameters such as laser power, spot size, cutting speed and cutting gas velocity on the cutting depth are discussed. The results of the mathematical model are compared with experimental data. Such comparison provides a means of determining the effective absorptivity during laser materials processing.

A Massively Parallel Ab Initio Molecular Dynamics Simulation of Polymers and Molten Salts

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Abstract

A new *ab initio* molecular dynamics (AIMD) simulation code based on planewave-pseudopotential local density functional method has been developed and implemented on a massively parallel computer using a high performance fortran. The new code uses significantly smaller amount of memory and disk space than the previous version. With the new code, it is possible to simulate geometric, dynamical, and electronic properties of large molecules and polymers containing more than 200 atoms from first principle. In addition, it allows both periodic and quasifree boundary conditions. Extended system such as polymers can be simulated with the periodic boundary condition whereas finite-size systems including charged systems can be calculated with the quasifree boundary condition. Various benchmark tests demonstrate the high degree of accuracy and efficiency of parallel processing. This code is applied to the simulation of semiconducting polymers with a large repeat cell and molten salts based on aluminum chlorides.

AIRCRAFT SUPER CAPACITOR BACK-UP SYSTEM

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Abstract — The feasibility of the use of a super capacitor to improve the back-up power system of an aircraft was studied. The back-up power system consists of a super capacitor charger, a bank of super capacitors, and boost dc-dc converter. A novel super capacitor charger was invented. A boost dc-dc converter was used to transfer the energy from the super capacitor to the 28-V dc bus and regulate the voltage. A new control technique introduced recently was used to achieve a good line regulation of the boost converter over a wide input voltage range. Experimental results indicate that a super capacitor and DC/DC converter can be used to improve the regulation of the bus voltage of distributed power systems.

CORROSION RESISTANT SOL-GEL COATINGS FOR AIRCRAFT ALUMINUM ALLOYS

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Abstract

Sol-gel films were investigated as potential replacements for chromate-based surface treatments on aircraft aluminum alloys. Aluminum alloy 2024-T3 test coupons coated with protective sol-gel films were shown to provide greatly enhanced corrosion protection compared to current protective treatments such as alodyne 1200. Although substantial cracking and pinhole defects were found in most of the films prepared, improvements of up to six orders of magnitude in corrosion resistance were found for selected films. The most promising protection improvement was found in the case of a passivating cerium doped silica subbing layer with an organically-modified silicate (ormosil) overcoat. The sol-gel bilayer was found to give corrosion protection which rivaled or exceeded the complete alodyne/primer/paint topcoat system currently in use by the Air Force.

SKILL EVALUATION OF HUMAN OPERATORS

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Abstract

The skills of humans performing tasks are often evaluated using Fitts' law, which is described by a straight line in coordinate system of execution time and task difficulty index. Then, the inverse of the slope of the straight line is called the execution capacity of the human.

The aforementioned variables are calculated from data of experiments which usually can be considered random variables due to human factors involved. In this framework, our study focuses in the variability of variables in Fitts' law and in the execution time. Indeed, we have determined the mean and standard directions for *individual* performances and also for the performances of a *group* of individuals. Thus, the skills of an individual can better be compared with those of the other individuals.

Fitts' law assumes that the performance demonstrating skills in a task is described by one variable. However, Fitts' law is ageometric approach which is difficult to apply when the task performance is characterized by two or more variables. Our study introduces a novel probabilistic skill index to evaluate skills in tasks; it chan be used even when a task is characterized by two or more variables. The probabilistic skill index does provide a broader basis for the skill evaluations of individuals. Moreover, the individuals performing tasks requiring certain skills can then be compared objectively on the basis of the probabilistic skill index.

AROMATIC HYDROCARBON COMPONENTS IN DIESEL, JET-A AND J-8 FUELS

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Abstract

JP-8, Jet-A and diesel fuels were analyzed by Gas Chromatography-Masspectrometry(GC-MS) to identify the chemical components, especially aromatic hydrocarbons. These analyses were performed with GC cross-linked silicate capillary columns interfaced with a mass selective detector. JP-8 (Kelly A. F. B.) contains approximately 28 alkylated benzenes(11 %) and 13 naphthalenes(6%). Most of alkylbenzenes had molecular weights less than 150, such as ethylbenzene, dimethyl-, ethylmethyl- , methylpropyl-, ethyldimethyl-, trimethyl-, diethylbenzenes. Naphthalene derivatives were decalin, methyldecaline, methyl- dimethyl- and trimethylnaphthalenes. Jet-A (Berry Airfield) has 18 alkylated benzenes (8 %) and 12 naphthalenes(4%). Diesel fuel (Kelly A. F. B.) had 5% alkylated benzenes, 12 % naphthalenes and approximately 83 % hydrocarbons and others. We discovered 23 alkylated benzenes and 23 other aromatic hydrocarbon derivatives in diesel fuel. Mass spectra were effective to identify aromatic compounds but not accurate to determine positional isomers.

MENTAL WORKLOAD CLASSIFICATION VIA PHYSIOLOGICAL SIGNAL PROCESSING: EOG AND EEG ANALYSES

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ABSTRACT

Accurate and efficient mental workload classification and assessment based on physiological data have many important applications ranging from operator monitoring to interaction and control of man/machine systems. The physiological signals studied in this project are the electrooculogram (EOG) and electroencephalogram (EEG). An efficient and robust eyeblink detection algorithm was developed based on nonlinear analysis of the EOG signal. The effectiveness of the algorithm was demonstrated via the analysis results of several benchmark test data sets provided by the Armstrong Laboratory. To quantify EEG changes associated with different mental workload conditions, a parametric model (autoregressive model) was established for each properly segmented EEG. The spatial relations among 57 channels of EEG were examined using Itakura distance. Preliminary analysis results indicate that the spatial distance maps exhibit unique patterns for various mental workload conditions. A workload indicator is then developed to capture the distinct distance patterns and data analysis results show promising classification results.

Theory of Electron Acceleration by HF-Excited Langmuir Waves

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Abstract

A generalized Fokker-Planck equation is derived to describe the diffusion effect of the HF heater-excited Langmuir waves on the background electron distribution. It is shown that the quasi-linear diffusion process alone can not produce very energetic electron flux in 20 eV energy range due to the friction force of the bulk plasma. On the other hand, the diffusion coefficient contributed by nonlinear wave-particle interactions has a nonzero value in that energy range and the friction is not able to balance it. Such a nonlinear diffusion process is driven by the beat product at the frequency sum of two oppositely propagating Langmuir waves. The wide energy range continuously covered by this nonzero nonlinear diffusion coefficient enables some of the electrons to be accelerated continuously from its low energy end to the high energy level. The numerical results show that the energetic electron flux (>20 eV) thus pproduced is large enough to account for those detected in the in-situ particle measurement using a rocket fly at Tromso and by the incoherent Backscatter Radar at Arecibo during the HF heating experiments.

CRACKS AT INTERFACES IN BRITTLE MATRIX COMPOSITES

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and
Herbert F. Miles, II, Graduate Research Assistant
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Abstract

Interfaces play a key role in the toughness of brittle matrix composites. This study is revealing how friction, toughness, and roughness act in concert to determine the extent of interfacial sliding which may occur near the tip of an impinging matrix crack. The study is bolstered by experiments of cracks at frictional, rough interfaces which reveal the three-dimensional nature of the crack-interface interaction. Critical crack angles are measured at interfaces in dual DCDC specimens.

ANALYSIS AND DESIGN
OF GAIN SCHEDULED MISSILE AUTOPILOTS

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Abstract

The application of a recently developed methodology for gain scheduled control system synthesis to the design of a pitch channel missile autopilot is described. Conditions are given under which a nonlinear gain scheduled autopilot exists that linearizes to a prescribed family of linear autopilots designed over a wide operating envelope. Based on this, a nonlinear gain scheduled autopilot is constructed that makes direct use of aerodynamic missile data in tabular form. Nonlinear simulation results indicate satisfactory performance over the flight envelope.

MULTICHANNEL AUTOREGRESSIVE MODELING AND SPECTRAL ESTIMATION METHODS FOR AIRBORNE RADAR ENVIRONMENT

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Abstract

The ability of multichannel AR models to properly model the received signal in an airborne radar environment was investigated. A physical model was used for generation of noise, clutter, and signal returns. Two different methods of the multichannel AR parameter identification were used, solution of the standard Yule-Walker and Overdetermined Normal Equations Methods. Results show that AR models of modest order well match the 2D power spectrum (computed by the 2D Fourier transform of the received data matrix) of the radar returns. The implications of acceptable modeling performance might indicate successful operation of innovations based detection algorithms (IBDA) in similar radar scenarios.

CHARACTERIZATION METHODS FOR ADHESION STRENGTH BETWEEN POLYMERS AND CERAMICS

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ABSTRACT

Methods in characterization of adhesion strength between soft material to rigid materials were presented. The advantages and disadvantages of various methods were discussed in terms of fracture mechanics. Double cantilever beam method and double lap shear test are to be used to characterized the adhesion strength between the clay reinforced Nylon-6 to a ceramic material. The amount of material needed for these mechanical testing is much lesser than the normal dumb-bell shaped tensile specimens. Thus, these mechanical methods can be adapted by the chemist at the Phillips Laboratory where current development of POSS containing polymers can be examined in a "real" application environments.

PRELIMINARY STUDIES OF HUMAN ELECTROENCEPHALOGRAM (EEG) CORRELATES OF Gz ACCELERATION TOLERANCE

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Abstract

This report presents preliminary findings of two separate studies whose goal is the development of a system for detection of acceleration (+Gz) induced loss of consciousness (G-LOC) in pilots of high performance fighters. The purpose of the first study was to evaluate a helmet mounted system; presently under development by the Israeli Air Force for determination or detection of Gz induced loss of consciousness (G-LOC). The results show large amounts of delta activity in the EEG; however, the dry EEG system has a greater percentage of delta when compared to the wet EEG system. Of more interest is the increase of high frequencies in the Beta bands (Beta 3 to Beta 6 or from 24 to 36 Hz), as the G-level increases to 9-Gs. The high frequency increase is greater and easier to note in the wet EEG data than in the dry EEG data.

For the second study, the subjects were in different stages of training; thus, the acceleration profile for any subject is based on the individual's training requirement. The acceleration-profiles in this study could include any set of rapid onsets to 2-Gz, 4.5-Gz, 5-Gz, 7-Gz, 8-Gz and/or 9-Gz for varying duration of time. More advanced trainees experience the Standard Air Combat Maneuver (SACM). In this study, it was observed that the experienced rider's (subject A) anti-G countering maneuver during the SACM showed maximal EEG activity at the first +7-G encounter. The maximal anti-G countering strain resulted in high levels of physiological electrical activity in the 16 to 32 Hz range. Duing subsequent +7-Gz accelerations, less EEG activity was observed in the 12 to 28 HZ range. The results from the inexperienced centrifuge rider (subject B) indicate unusually high activity during the 15 seconds of sustained (constant) Gz-levels of 5 and show elevated EEG activities in the 12 to 20 Hz range during 5-Gz acceleration and Beta 1 (12-16 Hz) during the 7-Gz acceleration. An evaluation of the EEG spectra at 7-Gz shows a very high peak at 13.6 Hz on all EEG channels; however, it is most prominent in the parietal area (40% of spectral power) as compared to the occipital area (34% of spectral power).

BIOGEOCHEMICAL ASSESSMENT OF NATURAL ATTENUATION OF JP-4 CONTAMINATED GROUND WATER IN THE PRESENCE OF FLUORINATED SURFACTANTS

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Abstract

The biogeochemistry of natural attenuation of petroleum-contaminated ground water was investigated in a field study. The focus of the study was a fire training site located on Tyndall Air Force Base in Florida. The site had been used by the Air Force for about 11 years in fire fighting exercises. An on-site above-ground tank of JP-4 provided fuel for setting controlled fires for the exercises. Various amounts of water and aqueous film forming foams (AFFF) were applied to extinguish the fires. The sources of contamination included leaks from pipelines transporting the fuel, leaks from an oil/water separator, and runoff and percolation from the fire fighting activities. Previous investigations had identified jet fuel contamination at the site, however no active remediation efforts have been conducted to date. The goal of this study was to use biogeochemical monitoring data to delineate redox zones within the site and to identify evidence of natural attenuation of JP-4 contamination. Due to the time constraints of the study, monitoring wells already existing on the site were used for ground water sampling. Four sets of grab samples were collected and analyzed for inorganic and organic water quality parameters. Specific chemical derivatization tests were conducted to provide qualitative evidence of the presence of biological metabolites within various redox zones. In addition to identifying several hydrocarbon metabolites, fluorinated surfactants (AFFF) were detected down-gradient of the hydrocarbon plume. The results of this study provide a frame-work for follow-up modeling and field studies to evaluate the fate, transport, and natural attenuation of JP-4 components and metabolites in the presence of AFFF.

ACOUSTO-OPTIC RETRO-MODULATOR

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Abstract

In this paper a laser modulation device for space communications is proposed. It will utilize the acousto-optic effect in quartz to provide a rugged, monolithic, compact design for a space platform retro-modulator. In contrast with many other, modulation technique, the device can be polarization insensitive, able to tolerate a hostile environment, handle high laser intensities, and provide 1 - 1000 Mhz of modulation. All of this is based on currently available technology.

DETERMINATION OF 3D DEFORMATIONS, FORCES AND MOMENTS OF AIRCRAFT TIRES WITH A SYNCHRONIZED OPTICAL AND ANALOG SYSTEM

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Abstract

The use of optical sensors for geometry and vibration measurements has received a great deal of attention. A vision system may be placed in a remote distance with passive or active light sources such that the motion history can be detected. With a high-speed image processing unit, the measured data may be displayed on a PC in real time. This report describes the measurement procedures and results for aircraft tire properties with Wright State's Optotrak and analog system. The current setup can detect 3D positions of pre-defined points. Infrared light emitted from the markers is received by the vision sensor and digitized for display. The optical system is synchronized with analog (non-optical) devices, such as load cells and pressure transducers. Tires were tested on two machines. In the first experiment, the tire (KC-135 and F-16) was mounted on a Tire Force Machine (TFM), where the vertical, lateral and longitudinal (fore-aft) forces were applied. The system recorded the tire deformation, force, moment, TFM tolerance and table movement as the table travels. The side slip and the lock-up braking force verses the normal load and various yaw angles and their relation with 3D tire deformations were measured. The second experiment involved the use of an 84" dynamometer. An F-16 tire was mounted on the axle where free rolling and brake tests were conducted. The data for the dynamo testing included tire deformations, drum speed, normal force and brake torque.

The measurement and data acquisition were successful. However, due to the collection of tremendous data sets and a limited time for analysis, this report can only present some preliminary results in the global coordinate system. Detailed studies will be conducted in the near future if the time and fund are available.

Abstract

As the sophistication of adversary weapon systems and tactics advances, effective operation of an aircraft in air combat becomes a complicated task. A large amount of information is available to the pilot and many quick decisions and responses need to be made. Many problems in this area involve the development of machine intelligence. Expert systems have been often the choice in solving such problems. Design of an expert system involves the acquisition of knowledge from experts, expression of the knowledge into rules or procedures, and implementation of the intelligent system that uses these rules and procedures. Collecting and organizing the knowledge into a rule base is not an easy job. In contrast to the knowledge-based technique, example-based learning has received increased attention in the past two decades. Neural networks are the major mechanism for example-based learning. One advantage of example-based learning is that, rather than explicit knowledge, cases of desired behavior are collected. This type of learning makes generalizations from observed examples. Even with relatively few examples, an adequate decision could be generated from a well developed example-based learning structure. The Pilot Vehicle Interface Technology Section of Wright Laboratory has shown interest in potential applications of the example-based technology to pilot-vehicle interfaces (PVI) and decision aids. The author was supported under the Summer Faculty Fellowship Program for an 8-week period to investigate the issue. In this report, promising areas in the PVI and related fields to which the neural network technology could be applied are discussed. Topics focus on neural networks for rule development, air combat maneuvering, and voice input. A new special neural network, which can handle problems with high dimensional input space and could be adequate for many PVI and decision aid problems is also introduced.

STRUCTURAL BALLISTIC RISK ASSESSMENT – FRACTURE MODELING

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Abstract

The structural ballistic risk assessment of solid rocket motors requires a precise numerical simulation of the motors' firing. The simulation has to integrate technologies in various disciplines, including burnback, internal ballistics, and nonlinear structural analysis. One essential aspect in achieving a successful simulation is to consider the effect of cracks in propellant and debonds between propellant and insulator. The purpose of this research is to evaluate fracture mechanics models currently in the FEINT program and to identify new fracture models to be incorporated into FEINT so that its capability for predicting fracture behavior of motor firing can be improved.

In this report, the Thiokol's comprehensive study on the influence of defects on rocket motor firing performance is reviewed first. The fracture mechanics models currently in FEINT and their assumptions, computational approaches, and limitations are evaluated next. Several new fracture models such as Schapery's J_V integral, Hillerborg's fictitious crack model, Bazant's size-effect model, and Jenq and Shah's two-parameter fracture model are described, and their suitability to be applied to motor firing simulation is discussed. Finally, suggestions for achieving a better numerical simulation of crack and debond propagation in solid rocked motors are proposed.

STUDY ON DEAD RECKONING TRANSLATION IN HIGH LEVEL ARCHITECHETURE

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Abstract

In HLA, the concept of dead reckoning (DR) is extended to attribute extrapolation. The federation can use any formula that is agreed upon by the participating federates. If a non-DIS-standard DR algorithm is chosen, a DIS-compatible simulator has to modify its software to join the federation. The cost can be significant for this kind of modification. This paper suggest the use of dead-reckoning translators to solve this problem. To assist the study, a software tool Dead Reckoning Translator Simulation Program (DRTSP) was designed and developed. It is a MATLAB based program using the Graphic User Interface (GUI) to provide a user friendly environment. A sample flight trajectory recorded from a flight simulator is used to test the algorithms. The output of the program are the number of PDUs (updates) and the errors of each dead reckoning algorithms. Conclusions are drawn from the results of the numerical experiments.

Control of Linear Systems with Saturating Actuators – with Applications to Flight Control Systems

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Abstract

Two problems in the control of linear systems with saturating actuators are treated, resulting in two design techniques.

1. A composite nonlinear feedback design based on a nominal linear feedback is proposed for linear systems with position limited actuators. The design yields nonlinear feedback laws that both increase the speed of closed-loop system response to the command input and reduce the overshoot, while not imperiling the performance achieved by the nominal linear feedback controller in the face of actuator position saturation. A flight control system is used to demonstrate the design.
2. A robust stabilizing feedback design technique for linear systems with rate limited actuators is proposed. The design combines two design techniques recently developed for linear systems with position limited actuators, piecewise-linear LQ control and low-and-high gain feedback. An F-16 class open-loop unstable fighter aircraft model is used to demonstrate the effectiveness of the proposed design method. The combined design takes advantages of both design techniques, while avoiding their disadvantages.

These two design techniques are presented as two separate parts of this final report.

THEORY, MODELING AND ANALYSIS OF AMTEC

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Abstract

Alkali-Metal Thermal-to-Electrical Converter (AMTEC) is a high temperature regenerative concentration cell for elemental sodium which converts thermal energy directly into electrical energy. The efficient operation of AMTEC cell involves several challenging heat and mass transfer porocesses which require some through investigation. An actual AMTEC cell consists of several sodium vapor tubes. In order to understand its working principle and develop a good working model we first started our analysis with a single-tube device. For that a single-tube AMTEC cell is divided into four flow nodes. The pressure drop is calculated for each node in order to calculate the total pressure drop through the tube. The flow equations are derived in continuum, free molecular motion and transition regimes. As expected the molecular flow regime is more challenging. We studied this regime with three different approaches. None of them agrees with the observed data in the high current region. A fourth option, called Dusty Gas Model (DGM) is introduced . This approach is expected to remove the discrepancy between the observed data and the results predicted by this model. If so, this model will be applied to multi-tube cell.

THE ILLUSION OF CONTROL AND PRECISION ASSOCIATED WITH BASELINE COMPARISONS

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Abstract

Although proper controls are a necessity for valid scientific conclusions, many researchers do not understand how to incorporate proper controls into scientific investigations. Baseline measures are often used as control measures, despite the inadequacies of baseline measures to reflect effects due to the experimental manipulations. The following exposition outlines the problems with baseline observations, and provides an example that demonstrates the increase in experimental and statistical efficiency associated with proper experimental controls.

ESTIMATING THE AREA OF ARTIFICIAL SPACE DEBRIS

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Abstract

The physical characteristics of breakup debris is essential to properly estimate the orbital debris environment and its hazard to spacecraft. This report presents, for the first time, a novel method to make direct measurements of the actual physical cross-sections of debris from ground-based breakups. The methodology of the laboratory experiments is presented and the results of these measurements are examined in comparison to other models for the physical characteristics of debris. For small objects, less than five cm in average diameter, the models and measurements agree well. The objects above five cm diverge from the predicted cross sectional area for debris. This may have a large effect on modeling of the debris environment [Madler (1994)].

DESIGNING INSTRUCTION FOR DISTANCE LEARNING

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Abstract

This study explores new models and methods for use by instructional designers and developers for exploiting the technology of distance learning in creating more effective instruction. Organizations are beginning to change their question from "Should we be doing distance learning?" to "When are we going to begin distance learning?" Traditional classroom models for instructional design and development need modification for application in a distance learning environment. An extensive review of the literature was conducted to provide both practical guidelines and theoretical considerations in transforming traditional instruction to distance delivery lessons. The study looks at many aspects of the design process from selection of instructional strategies and activities to the role of the instructor in the design and delivery of the content. Particular attention is paid to classroom interaction and learner participation, collaborative learning and contingency planning. An integrated behaviorist/constructivist model for distance learning programs is discussed along with learner autonomy and locus of control. Media presentation is also examined for a variety of transmission systems.

A conceptual model for holographic reconstruction and minimizing aberrations during reconstruction of cylindrical holograms.

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Abstract

A simple model reproduces most, though not all, the features of holographic image formation. In looking at a holographic image, it is as though you are looking at the original object through the hologram surface, but the holographic volume is filled with a medium with index of refraction $\mu = \lambda/\lambda_0$, where λ is the reconstruction and λ_0 the reference wavelength.

I calculate the wave aberration for reconstruction of a point on the axis of an 18 in. diameter cylindrical hologram, with the reference beam (λ_0 = 694 nm) located 62 in. along the axis from the point, for different locations of the reconstruction beam at wavelengths 688 and 632 nm. For the two reconstruction wavelengths, the region in which to place the reconstruction beam in order to minimize the aberrations is found. These regions are consistent with the rule to place the reconstruction beam where it will satisfy the Bragg condition at the pupil.

COMPUTATIONAL STUDIES OF THE REACTIONS OF CH_3I WITH H AND OH

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Abstract

Transition states for attack by H and OH radicals at the C-H and C-I bonds of CH_3I have been characterized at the Gaussian-2 level of theory. The results are employed in a transition state theory analysis to obtain *ab initio* rate constants and product branching ratios. For the H reaction the major pathway is predicted to be I-atom abstraction, while for OH attack H-atom abstraction is faster than HOI formation. The calculated rate constants agree well with available kinetic measurements at around room temperature. The results yield rate constant expressions applicable to combustion conditions and which are employed in a model of a stoichiometric CH_4/air flame to assess the contributions of the two title reactions to the flame chemistry of CH_3I. H-atom attack is the fastest reaction, followed by OH attack. Above 900 K unimolecular decomposition of CH_3I is predicted to be the next fastest removal pathway, followed by O-atom attack.

TIME-TO-CONTACT JUDGMENTS IN THE PRESENCE OF STATIC AND DYNAMIC OBJECTS: A PRELIMINARY REPORT

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Ronald D. Dunlap, Doctoral Candidate
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Texas Tech University

Abstract

The accuracy of time-to-contact (*TTC*) judgments in computer-generated visual displays was investigated in conditions that included no, static, or dynamic (moving) non-target stimuli. The number of such stimuli, and their direction and relative speed of movement also were manipulated. Analyses indicated that our tasks yielded traditional *TTC* functions, with undersestimation increasing as actual *TTC* increased (2-, 4-, 8-sec). The direction of non-target stimuli movement influenced *TTC* judgments only when they traveled at the same speed and in the same direction as the target. This effect was most pronounced at the longest *TTC*. Neither the number of non-target stimuli, nor non-target movement in general, affected *TTC* estimates. We suggest that a non-target stimulus may play several roles (have several influences) depending on the task requirements and the display configuration. Ordinarily one would think of non-target stimuli as distractors, but we suggest that when a non-target stimulus moves in the same direction and at the same speed as a target, it can assume the role of a "surrogate target," providing visible cues with which to judge target *TTC*. Within the limits of the conditions of this study, we conclude that *TTC* estimates are very robust, and are not easily influenced by otherwise extraneous variables, including accidental and potentially adverse testing environments. Performance on a *TTC* task, however, also may be determined by the adaptive nature of general strategic cognitive processes. We propose further research to determine if, when, and how extraneous stimuli may influence *TTC* accuracy, and what other adaptive and non-automatic processes might be inloved.

AN ASSESSMENT OF THE CURRENT TREND CAPABILITIES OF THE MH53J VIBRATION MONITORING SYSTEM

S. A. McInerny

ABSTRACT

The findings of a review of the vibration monitoring program on the MH53J Special Operations Forces aircraft is summarized. The new data acquisition unit permanently installed on the MH53J aircraft, called the VMS, performs three different functions: track and balance; acquisition of vibration trend data; and acquisition of monitor data. This review focused on the vibration trend capabilities of the program, as success of envisioned enhancements to the system rests on trending capabilities. Shortcomings in the trending aspects of the current system are identified. These include a lack of clearly defined expectations for the vibration trending program, against which its performance might be judged. Furthermore, while trend data is regularly acquired on aircraft at Kirtland Air Force Base, this is true only for selected aircraft at Hurlburt Field. There is almost no trend data being acquired on aircraft at Osan and Mildenhall. On the technical side, the locations of the vibration sensors are not optimal and no spectral averaging is performed. The latter two factors are suspected of being the major contributors to the large variation seen in trend levels measured under nominally identical mechanical and operating conditions. Due to sensor type, location, and mounting, as well as the lack of zoom analysis capabilities, H53 gearbox and bearing diagnoses cannot be adequately performed with the VMS as currently configured. Improvements in effective aircraft maintenance and aircraft sustainability can be expected if these system shortcomings are addressed.

In order to improve the trend capabilities of the vibration monitoring program, it is recommended that clear, specific, realizable program goals be developed. These should include a detailed list of those mechanical components and fault conditions that are to be monitored. A stepped plan for improving the quality of the trend data is presented. Regardless of changes that might be made in hardware (e.g., sensors, data acquisition unit), software (e.g., the database program that tracks the trend data), or personnel, the effectiveness of the vibration monitoring program ultimately depends on comprehensive program oversight. Responsibility and, by implication, culpability for cost effective program growth and performance should assigned to an appropriate Air Force representative. The program must have the support of impartial technical expertise that remains abreast of current developments in the field. This is especially critical in a funding environment where open bids are difficult to issue and the incorporation of new program capabilities into existing contracts is the only practical option

A REVIEW OF MICROWAVE TERRAIN CLUTTER MEASUREMENTS AT BISTATIC ANGLES

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Abstract

This paper reviews bistatic radar scattering measurements of terrain (clutter) surfaces that have been reported in the open literature. Brief descriptions of bistatic clutter measurement programs, conducted during the past three decades, are given. Normalized radar cross section (NRCS) values are tabulated and parameterized with respect to scattering geometry, radar frequency, polarization, and terrain type, and recommendations for future measurement programs, needed to extend the existing database, are given. This report summarizes the author's research performed over a 30 day period during the summer of 1996 as a participant in the AFOSR summer faculty research program at Rome Laboratory, Hanscom AFB, MA.

INVESTIGATION OF HOLOGRAPHIC PIV AND HOLOGRAPHIC VISUALIZATION TECHNIQUES FOR FLUID FLOWS AND FLAMES

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ABSTRACT

The use of holography in diagnostics of fluid flows and flames is investigated in several flow configurations for two purposes: as a visualization tool and as a quantitative full-field velocity measurement tool. Holography, having the capability of three-dimensional (3D) representation of spatial objects, particle ensembles and multiphase flows, holds great promise as a diagnostics tool — both qualitative and quantitative — for spatially and temporally evolving complex flow structures. Full-field velocity fields can be measured by Holographic Particle Image Velocimetry (HPIV or Holographic PIV), which potentially can fulfill the need for detailed velocity and vorticity data in various turbulent and complex flows encountered in aircraft engine combustion and other Air Force applications.

For holographic visualization, a snap shot of a transient fluid flow is recorded on a hologram which can reconstruct its 3D structure at that instant, while a series of snap shots can record the dynamical evolution of the 3D structure. The 3D images of the flow reconstructed from the hologram can be viewed from different angles, focused at different distances and with different magnifications, allowing analysis of different scales of the flow. This is a very powerful technique for capturing the instantaneous 3D (volumetric) information of turbulent flow phenomena, comparing to standard flow visualization techniques which are mostly restricted to two-dimensional (2D) images. In Holographic PIV, the purpose is to map out the *quantitative* instantaneous volumetric 3D velocity fields with high spatial and temporal resolution. Double exposures in rapid succession are made on a hologram to record millions of flow-tracing particles at two instants, and the hologram then reconstructs the particle images for velocity (displacement) extraction and provides spatially resolved 3D velocity field data. This is an innovative technique; its development is highly challenging. Promising results have been demonstrated in several university research labs as well as in Wright Laboratory in this Summer Research project.

We have developed an innovative holographic flow visualization method based on In-line Recording Off-axis Viewing (IROV) technique, and a basic double-exposure HPIV system which can be conveniently changed between IROV and Off-Axis configurations, at the Wright Laboratory. The IROV configuration enjoys the simplicity of optical geometry and operation while reducing speckle noise by avoiding the superposition of speckle-generating light waves during reconstruction. The Off-Axis configuration allows even higher seeding density by reducing the recording of speckle-generating light waves and by spatial separation of components in reconstruction. It nonetheless involves more complexity in geometry. Our future work include improvement of data processing and implementation of HPIV for vortex-flame interaction studies.

NEURAL BEAM STEERING AND DIRECTION FINDING

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Abstract

In this paper, we investigate algorithms for direction finding and beam steering using a degraded antenna. The algorithms can be implemented by means of neural networks. The training of these neural networks does not involve any nonlinear optimization. On several data sets, our results are comparable with those obtained with previously studied radial basis function networks. In the case of direction finding, they provide a substantial improvement.

BAND GAP CALCULATIONS ON OLIGOMERS WITH AN ALL-CARBON BACKBONE

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ABSTRACT

Attempts were made to calculate the band gap of various conjugated oligomers with an all carbon backbone. Computational software (Gaussian, Gamess, and HyperChem) was utilized in this work. Extrapolation of the results for the oligomers to the polymeric materials was made to predict candidates possessing desired conductive and nonlinear optical properties.

ENVIRONMENTAL COST ANALYSIS: CALCULATING RETURN ON INVESTMENT FOR EMERGING TECHNOLOGIES

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Abstract

This research examines the process of calculating the Return on Investment (ROI) for emerging technologies. The report illustrates the relationship between means and costs associated with implementing appropriate technologies to solve a compliance, remediation or source reduction problem. Major cost factors were identified by comparing emerging technologies to a baseline capable of achieving equivalent end results. The range of the costs captured for each alternative was developed by a decision criteria model and included: direct, indirect, liability, and intangible costs. The tabulation of total costs was input to conventional Net Present Worth (NPW), Internal Rate of Return (IRR), and Benefit Cost Ratio (BCR) equations, which were presented to solve for the time value of the total cost estimates. Finally, the Return on Investment (ROI) was calculated for an emerging technology based on results of the life-cycle cost estimate.

HYDROGEN AND HELIUM ION IMPLANTATIONS FOR OBTAINING HIGH-RESISTANCE LAYERS IN N-TYPE 4H-SILICON CARBIDE

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Abstract

Light ions like hydrogen and helium were used to obtain high-resistance layers in n-type silicon carbide. Ion implantation was used to dope silicon carbide with light ions. Maximum resistivities of the order of 10^7 and 10^8 Ω-cm were observed for hydrogen and helium implantations, respectively. The high-resistance of the implanted layers starts to decrease after annealing at 600°C. Rutherford backscattering measurements indicate the relationship between high-resistance and implantation damage.

Least Squares Marquardt Calibration of Dielectric Resonator Measurements

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Abstract

Dielectric resonators (DRs), consisting of high temperature superconducting (HTS) thin-films for the end caps, are useful as microwave characterization tools, and as components in microwave systems (*e.g.*, sharp-skirt miniature filters in cellular base stations). In HTS DR measurements, because of the extremely high Q's possible (of the order of 10^6), the measured parameters are very sensitive to the background "noise" contributed by the coupling mechanism, case modes, radiation, etc. Therefore, it becomes important to properly calibrate all the background information in order to accurately measure the unloaded Q factor of the resonator. The research reported here pertains to the application of a non-linear curve-fitting procedure, the least squares Marquardt (LSM) algorithm, to accurately filter out the background noise and extract the unloaded Q of a DR. It has been observed that the background noise manifests out of the resonant band as a sinusoidal envelope. Therefore, an appropriate model of the measured data that we employ is a linear fractional transformation corresponding to mapping of a pure Lorentzian in the complex plane, multiplied by a sum of complex exponentials pertaining to the standing wave modes of the loop-coupling mechanism which corrupt the resonance curve. We have used this composite non-linear transformation to model raw data from a DR with copper end-plates. Preliminary analysis shows that the LSM fit is quite satisfactory even in the case of highly corrupted data. In future, we anticipate to vaildate this algorithm with measured data on HTS DRs.

JAVA-BASED APPLICATION OF THE MODEL-VIEW-CONTROLLER FRAMEWORK IN DEVELOPING INTERFACES TO INTERACTIVE SIMULATIONS

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Abstract

Interfaces to simulations serve to portray the dynamic behavior of the modeled system. In visual interactive simulations, user interfaces allow an analyst to also interact actively with the executing simulation. Traditionally, the software to display the simulation model and to facilitate user interaction are embedded in the simulation model. Such an integration makes it difficult to maintain large simulation programs and pose limitations in the development of multiple interfaces to a simulation model. This article presents a Java-Based Architecture for Developing Interactive Simulations (JADIS). JADIS applies the Model-View-Controller paradigm to the development of interactive simulations. In JADIS, the simulation model and multiple interfaces to them are separate processes that execute concurrently on distributed machines. JADIS integrates concepts from object-oriented programming, concurrent, distributed processing, and graphical user interface design in developing visual interactive simulations. This article describes the JADIS architecture and presents application of JADIS to the airbase logistics modeling domain.

A Summer Faculty Project for Anatomical Feature Extraction for Registration of Multiple Modalities of Brain MR

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Abstract

In this report, we introduce and discuss techniques developed for the extraction of anatomical structures in head MR images. The techniques include methods for the extraction of the eyes, brain lateral ventricles, and brain longitudinal fissure. The ultimate goal of the feature extraction is to allow the registration of different modalities of MR datasets of the same individual (for example, registration of a T1-weighted dataset with MRA, T2-weighted, and proton density datasets). After describing the methods, preliminary results of their application to a real dataset are exhibited.

FPGA IMPLEMENTATION OF THE XPATCH RAY TRACER

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Abstract

The ray tracing algorithm, often used in computer graphics for creating a 2-D picture of a 3-D world, is computationally intensive. Many attempts have been made in the past to reduce the processing time taken by this algorithm. In this research project, the ground work for implementing the algorithm onto Field Programmable Gate Array(s) is carried out. A systolic array architecture suitable for implementing the ray tracing algorithm onto FPGA(s) is proposed. VHDL codes for the different modules in the architecture are also developed. Since FPGA(s) are programmable in real-time, this method has a definite advantage over previous ones. It is hoped that the work will lead to the successful implementation of the algorithm on both the CHAMP and DRASTIC field programmable boards. Since the ray tracing algorithm is also used in the Xpatch software package used for the accurate electromagnetic scattering predictions, this work will also contribute toward reducing the processing time of Xpatch.

A LOW DIMENSIONAL CATEGORIZATION TECHNIQUE FOR C SOURCE CODE

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Abstract

The rapid development of efficient reliable software, especially large software, is not a task for which humans are particularly well suited. Humans have difficulty thinking about and manipulating large numbers of interacting factors when they develop complex software. On the other hand, complete automation of the software development task is unlikely since it requires a broad expertise in programming, software design, and an awareness of the goals and intentions that is at present uniquely human. The present paper explores how two new cognitive science techniques in recognition and categorizing can aid humans in the search of legacy software in software engineering. One technique recognizes objects in a vastly multi-dimensional space using eigenspaces, and the other technique automatically processes text using *n*-grams. The paper demonstrates how applying these techniques as cognitive filters might aid in the efficient search of legacy C software source code. A search or browser system that contained such a filter would immediately benefit human programmers reviewing legacy software and would be an important step towards developing an automated system.

FREQUENCY RESPONSE OF SEMICONDUCTOR PHOTOREFRACTIVE MATERIALS: ZnTe:Mn:V, GaAs:Cr, and CdMnTe:V

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Abstract

The photorefractive frequency response of three compound semiconductor materials, ZnTe:Mn:V, GaAs:Cr, and CdMnTe, were studied, using two beam coupling with a moving intensity grating, and no externally applied electric field. The data exhibit significant deviations from the expected Lorentzian response based on the single trap, single charge species photorefractive model. A sharply peaked behavior at low frequency is observed in all three cases, suggesting that its source is related to material properties that are particularly common to semiconductor photorefractives. Although the mechanism behind this unexpected frequency response has not yet been explained, possible models are presented and experimentally tested here and an effort to explain our results through numerical solutions of the nonlinear photorefractive equations is continuing.

THE DEVELOPMENT OF NEW LEARNING ALGORITHMS

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Abstract

Computational learning techniques serve as powerful methods of solving a variety of problems. This report investigates a new wire fitting function that can be used to facilitate computational learning. The wire fitting function is first evaluated and then applied to the development of both memory-based and gradient-based (neural network) algorithms to solve a problem involving optimal control. The memory-based algorithms are implemented in code.

ASSESSMENT OF DEVELOPMENTS IN MACHINE TOOL TECHNOLOGY

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Abstract

The Objectives of this research is to assess developments in machine tool technology and their implementations, and to recommend to Wright Lab Man Tech areas they should focus for future funding. The review covers historical background on U.S machine tool industry, identified the factors that caused the decline in U.S. machine tool industry in the early 1980, identifies on-going and planned developments in key machine tool technologies, trends and issues that affect the competitiveness of U. S. machine tool industry and manufacturing in general. These technologies are relevant to both defence and commercial manufacturing. The assessment is made in comparison with developments in Japan and Europe where appropriate.

This report is written by Dr. Anthony C. Okafor, Associate Professor of Mechanical Engineering at the University of Missouri-Rolla, who spent two months (May -July 1996) at the U. S. Air Force Wright Lab's Manufacturing Technology Directorate, Wright Patterson Air Force Base, Dayton, Ohio, as a 1996 Summer Faculty Research Associate. His research and stay was supported by the U. S. Air Force Office of Scientific Research (AFORS) . This report is written for the Chief of the Processing and Fabrication Division, Mr. Bruce Rasmussen. Questions regarding this report should be addressed to Dr. Okafor at Okafor@shuttle.cc.umr.edu, voice mail: (573)-341-4695.

BOUNDARY CONDITIONS AT A PLASMA-FACING SURFACE

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Abstract

It has recently been reported that almost every commonly-used plasma-facing material has an electron emission coefficient, defined as the average number surface-emitted electrons per incident plasma electron, with a value larger than the minimum value at which space-charge saturation occurs for plasma temperatures above ~50 eV. With this motivation, a fully-kinetic self-consistent theory capable of describing the plasma sheath under conditions of space-charge saturation is developed. The theory is then used to obtain boundary conditions which are suitable for incorporation into computer programs which simulate plasmas. *More details of the work described here is contained in a paper submitted for publication to Physical Review E.*

ASSESSING THE SUITABILITY OF THE CFD++ ALGORITHM FOR ADVANCED PROPULSION CONCEPT SIMULATIONS

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Abstract

The unified grid CFD++ algorithm was assessed for its suitability as an advanced propulsion concept flow field simulation tool. Six test cases were computed including a compressible flat plate, an unsteady inviscid shock tube, two supersonic backstep configurations, a supersonic open cavity studied previously by the author, and a three-dimensional inlet configuration. Structured grids were used in all cases for comparison against similar solvers. The code was run on several serial workstations and on two parallel machines. It was found that the code operates seamlessly in parallel and preliminary results demonstrated reasonable solution accuracy for the problems considered. This report also details the basic strategies to be followed when applying this code.

FURTHER ANALYSIS OF KILOHERTZ ORDER WAVES ASSOCIATED WITH ELECTRON BEAM OPERATIONS ON STS 46

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Abstract

This is a continuation of previous work to explain the 0.5 to 2 kHZ frequency electron modulations observed by the Space Particle Correlator Experiment (SPACE) during beam operations on STS 46. It was determined that the ions flowed past the orbiter too quickly to be generated by a conventional beam instability. New information regarding the nature of the waves suggest that the wave could be a standing wave phenomenon, whose frequency is determined by boundary conditions imposed by the cross-sectional edge of the beam and an additional boundary. It is suggested that the additional boundary is the mach cone caused by the speed exceeding the ion sound speed. A 1-D problem is analyzed and is seen to not be a physical solution. It is conjectured that a standing wave solution might exist for the 2-D problem.

A suggestion for additional study is made in the report.

GRATING LOBES IN ANTENNA ARRAYS

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Abstract

This work explores the problem of grating lobes in an antenna array. First describing the grating lobe, and then the trapped grating lobe, this paper then explores the use of different array feed configurations. Finally, a curvilinear array, as a perturbation of the linear array, is examined for its ability to extinguish the grating lobe. It is seen that certain feed networks can effectively produce nulling of selected grating lobes, while a parabolic curvature of the linear array succeeds only in eliminating the back lobes.

Examing Alternate Entry Points in a Problem Using Fuzzy Cognitive Maps

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Abstract

Fuzzy cognitive maps were developed as a way to evaluate alternate entry points in complex problem sets where there were many hidden interactions between attributes. FCM's are fuzzy digraphs that map causal linkages between concept nodes. To develop the techniques, the Jasper problem set was used. Participants viewed a video of a search and rescue mission, with relevant information spread throughout the tape. After viewing the tape, the participants, with the help of a facilitator, constructed a fuzzy cognitive map of their reasoning about potential solutions to the problem. Various techniques were used to construct the map, and to evaluate the edge strengths. With a completed map, information could be inferred in one of two ways. For a scenario, its initial conditions could be applied to the map, and a final state for the system determined. In a second way, the edge strengths could be used to define direct and indirect causal linkages.

ABSOLUTE RATES FOR CHEMICAL REACTIONS

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Abstract

There are a number of problems in atmospheric chemistry and flame chemistry that are of considerable importance to the Air Force. A fundamental understanding of the absolute rates of the pertinent chemical reactions will provide the basis for improved solutions to these problems.

A new computational procedure for the characterization of transition states for chemical reactions is proposed and tested. Previous calculations have frequently employed a single point high-level energy calculation at a transition state geometry obtained with a less expensive computational method, Energy[Method(1)]//Geom[Method(2)]. If we instead search the "inexpensive" intrinsic reaction coordinate (IRC) for the maximum of Energy[Method(1)] along this reaction path, the resulting "IRCMax method", Max{Energy[Method(1)]}//IRC{Geom[Method(2)]}, reduces errors in transition state geometries by a factor of four to five, and reduces errors in classical barrier heights by as much as a factor of ten. When applied to the CBS-4, G2(MP2), G2, CBS-Q, and CBS-QCI/APNO model chemistries, the IRCMax method reduces to the standard model for the reactants and products, and gives RMS errors in the classical barrier heights for ten atom exchange reactions of 1.3, 1.2, 1.0, 0.6, and 0.3 kcal/mol respectively.

The CBS barriers are incorporated into Eyring's absolute rate theory including tunneling through an Eckart potential barrier which includes variations in the zero-point vibratonal energies. These calculations reproduce the experimental absolute rates (which vary over eight orders-of magnitude) for five hydrogen transfer reactions with barriers ranging from 1 to 20 kcal/mol at temperatures from 250 K to 2500 K to within 20% RMS relative error.

These methods are now being used to obtain rate constants for important reactions of proposed halon replacements at combustion temperatures. It will soon be possible to experiment with many known and potential agents in many fire scenarios without ever lighting a match or otherwise starting a fire. This is the first step in the construction of a virtual fire laboratory where the computer takes the place of hardware, fuels and suppressants to make possible safe, fast, and effective evaluations of fire suppressants.

TEMPORAL-DISPLACEMENT STEREOGRAMS OF THE IONOSPHERE: AN EXPLORATION OF THEIR UTILITY IN THE ANALYSIS OF EQUATORIAL EMISSION DEPLETION BANDS.

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Abstract

Optical images of the night sky are a primary source of information in research on the ionosphere. Typically only one photometer is employed, and the resulting single-point-of-view images are analyzed primarily for information on the transverse size, shape and position of the structures of interest. The present project is concerned with exploring the potential of getting volumetric information from the optical images via optical stereograms. To obtain true stereograms would require employing two photometers an appropriate distance apart on the ground, each aimed at the same section of sky and each recording an image at the same time. We sought to approximate that ideal situation with images obtained by just a single photometer. We created temporal-displacement stereograms and examined them for the light they might throw on the potential utility of true stereograms. We concluded that they do not look very promising as a source of volumetric information in their own right, and they are not a sufficient basis for evaluating the potential informativeness of true stereograms.

RAPID PROTOTYPING OF SOFTWARE RADIO SYSTEMS USING FIELD PROGRAMMABLE GATE ARRAYS AND DSP MICROPROCESSORS

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Abstract

Field programmable gate arrays (FPGA) and monolithic DSP microprocessors are powerful technologies which can be used to maximum advantage in military software radio applications. The objective of this report is to examine the role of both of these technologies in the implementation of high performance military radio systems. A radio transceiver implemented using state-of-the-art DSP technology - often referred to as *software radio* - requires real time signal processing at a variety of bandwidths. In order to accommodate the needed bandwidths in a discrete time implementation, it is appropriate to use devices which are well suited to each stage of the system - fast, yet algorithmically simple devices for the wide bandwidth stages and slower, yet more flexible devices for the processing required at low bandwidths. This report examines the processing requirements of software radio, and assesses the role of the current generation FPGA, and DSP processor technology in implementing the algorithms required to make these radio systems function efficiently.

A NETWORK FLOW HEURISTIC FOR GRAPH MAPPING

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Abstract

We introduce a network-flow based approach to partitioning computation which can be modeled as a graph for parallel computers. This includes several problems in computational physics. We discuss some applications and ongoing work on implementing the algorithm.

DETECTION OF CONCEALED OBJECTS IN IMAGES: INVESTIGATION INTO WAVELET TRANSFORM BASED OBJECT ISOLATION TECHNIQUES

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Abstract

Wavelet transform based techniques were developed and investigated for isolation and enhancement of objects in images. The primary motivation is the development of image processing algorithms as part of an automatic system for the detection of concealed weapons under a person's clothing: a problem of considerable potential utility to the military in certain common types of deployment in the post cold war environment such as small unit operations. The issue has potential for other dual use purposes such as law enforcement applications. Wavelet decompositions of the currently available database, namely, noisy, low contrast, infrared images, were studied in space-scale-amplitude space. An isolation technique for separating potential suspicious regions/objects from surrounding clutter has been proposed. Based on the images available, the study indicates that the technique is very promising in providing the image enhancement necessary for further pattern detection and classification.

EFFECT OF SOLID SOLUTION ADDITIVES ON THE DENSIFICATION AND CREEP OF GRANULAR CERAMICS

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Abstract

The effect of solid solution additives on the densification and creep of granular ceramics was investigated for a model system consisting of CeO_2 solid solutions with Y_2O_3 as the additive. In the sintering of powder compacts at 1150 °C, the densification rate of CeO_2 at a given density decreased significantly with increasing Y^{3+} concentration. The reduction in the densification rate reached a factor of ≈100 for a Y^{3+} concentration of 6 atomic percent. Creep of dense cylindrical specimens was investigated at constant strain rates of 10^{-5} and 10^{-4} s^{-1} in air at 1200 °C. After compensation for differences in grain size, the creep rate was also found to decrease significantly with increasing Y^{3+} concentration. If the creep rate is assumed to be controlled by a mechanism of grain boundary diffusion, then the magnitude of the decrease is in good agreement with that observed in the sintering experiments. The results strongly indicate that it may be possible to predict changes in the steady-state creep behavior from observed changes in the sintering behavior provided that matter transport occurs by the same mechanism. They also indicate that the solid solution approach may have considerable merit for controlling the creep resistance of rare earth oxides that commonly have a high solubility for many cations.

A STUDY OF THE ABILITY OF TUNICATES TO BE USED AS GLOBAL BIOINDICATORS

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Abstract

The metal content of two solitary tunicates; *Mogula occidentalis* and *Styela plicata*; and two colonial tunicates; *Distaplia bermudensis*, and an as yet unidentified *Didemnum, spp.* collected from the same water system were analyzed for seven metals using Flame Atomic Absorption Spectrometry. Each was found to contain different amounts of Sr, Cd, Zn, Ni, Cr, Cu, and Fe.

The reaction of Styela plicata to elevated levels of chromium was also examined. The chromium studies included the following: 1.) Exposure of the tunicates to different contamination levels to evaluate the toxicity of this metal for this ascidian. 2.) Determination of whether the ascidians accumulated the metal as part of their food source or some other means. 3.) Determination of the extent of metal accumulation in the visceral mass compared to the tunic. 4.) Examination of the ability of the tunicates to depurate the metal from their tunic/visceral mass. 5.) Examination of the palatability of contaminated tunicates to predators and the extent to which the metal contaminant can be passed on to predators.

Computerized neuropsychological assessment of USAF pilots.

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Abstract

The neuropsychological assessment of US Air Force pilots presents several unique problems given their relatively high cognitive functioning. The US Air Force currently has a baselining procedure wherein student pilot candidates undergo computerized cognitive assessment. The intent of this assessment is to archive pre-morbid data against which to compare potential future post-accident performance. The current work provides the necessary background, clinical methods, and data in order to assess pilots who have suffered cortical insult such as trauma, disease, or toxin exposure. Methods are delineated for those with pre-morbid testing as well as for those pilots without such testing.

THE USE OF SOLID-PHASE MICROEXTRACTION (SPME) FOR THE LOW LEVEL DETECTION OF BTEX AND PAHs IN AQUEOUS LEACHATES

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Abstract

The use of Solid-Phase Microextraction (SPME) was investigated for the low level detection of BTEX and PAH compounds in aqueous leachates. Equilibrium partition coefficients and rates of sorption to the SPME fiber from aqueous solutions of the contaminants were determined. Equilibrium results compared favorably with literature data and demonstrate that the technique is particularly sensitive for the low level detection of PAH compounds, e.g., phenanthrene. Direct liquid phase sorption to the fibers was compared with sorption in the head-space above the aqueous solution. Results indicate that direct liquid phase sorption results in shorter equilibration times and in less interference for both laboratory prepared aqueous solutions as well as field leachates from complex fuel mixtures.

A PROCESS FOR SETTING UP COMPUTATION OF SWIRLING FLOWS IN THE AEDC H-3 ARC HEATER

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Abstract

The work reported here is concerned with setting up a computational method for determining the flowfield in arc heater type wind tunnels similar to the AEDC H-3 Arc Heater. The aim is to examine the relationship between the swirl flow, induced by injection ports in the intersegment slots and the tendency of the arc to impinge upon the walls. To do this, it is necessary to compute the flowfield in the arc heater geometry. Since the method uses the full Navier-Stokes equations, grid generation and initial condition generation programs were devised for future parametric studies to be performed. A checkout case was run for one set of stagnation conditions to ensure that the process can now be used for a series of parametric evaluations.

INVESTIGATION OF NECK MODELS FOR PREDICTING HUMAN TOLERANCE TO ACCELERATIONS

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Abstract

During an emergency ejection from aircraft, pilots are subjected to high accelerations that may cause injuries. These injuries, especially at the neck region, are exacerbated by any additional weight that is added to the head gear of the pilot such as by night vision goggles and helmet-mounted displays. There have been several studies on head acceleration in the z and x directions all of which have investigated the rigid body dynamics of the neck.

The objective of this study is to develop a finite element model of the cervical spine that predict the stresses in each vertebra by taking into account the viscoelastic characteristics of the neck. The loads and the moments at the head point (Occipital Condyle, OC) used for the model were determined by the rigid body dynamic response of the head due to G-y and G-z accelerations as reported by Sadegh (5) and Perry (16). The experimental data used were collected from the biodynamics responses of human volunteers during a acceleration in the z and y directions on the drop tower and the sled track facility at Armstrong Laboratory at WPAFB.

Three finite elements models were developed, bulk elastic, viscoelastic and continuum. I-DEAS software were used to create the solid models, loadings and the boundary conditions. Then, ABAQUS finite element software was employed to solve the models, and thus the stresses on each vertebral level were determined.

The results indicated that the stresses in the 10G-z case were comfortable below the injury region as determined by cadaver tests. Also, the stresses in G-y accelerations increased as the magnitude of the acceleration increases. This study by no means is a complete analysis of the cervical spine and was constrained by time limitation and the scop of the study. Further studies are referred to the next report.

LOW VOLTAGE ANALOG CIRCUIT DESIGN FOR RADIATION TOLERANCE

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Abstract

A low voltage analog circuit design approach for radiation tolerance is investigated. Analog circuits are sensitive to process variations, temperature, low voltage power supply and the total dose radiation. Nevertheless analog circuits can not be avoided in any modern integrated system. Even a conventional digital signal processing (DSP) system requires a preamplifier and an A/D converter and often also a D/A converter. Mixed-mode circuits involving digital and analog circuits are standard for modern circuit design. In this report a method for radiation effect MOS transistors modeling using conventional circuit simulators such as PSPICE is introduced. Furthermore an adaptive scheme to correct the circuit performance deviations due to the radiation effects is presented. Preliminary simulated results confirm the correct radiation effects modeling as well as the potential application of adaptive schemes to correct performance perturbations due to radiation.

AB INITIO MODELING OF THE ENTHALPIES OF FORMATION OF FLUOROCARBONS

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Abstract

The *ab initio* G2, G2(MP2), CBS-4 and CBS-Q quantum mechanical protocols and the parameterized BAC-MP4 procedure were used to calculate the enthalpies of formation ($\Delta_f H^o$) of ethane and the complete series of fluoroethanes, $C_2H_xF_{6-x}$, x=0-5. Results from all methods exhibited significant negative deviations from experiment. With the exception of the CBS-4 and BAC-MP4 procedures, the negative errors in the calculated enthalpies were observed to be linearly dependent upon the number of C-F bonds in the molecule. Application of a Bond Additivity Correction (BAC) parameter, Δ_{CF}, derived in an earlier investigation of fluoro- and chlorofluoromethanes, removed some, although not all of the systematic deviations. Introduction of a heavy atom interaction parameter, representing the effect of an attached carbon on the C-F bond error yielded corrected enthalpies which agree with experiment to within the reported uncertainties. The BAC-MP4 method, which has already been parameterized with generalized BAC's, yields calculated enthalpies which average approximately 10 kJ/mol below the experimental values of ΔH_f^o in the fluoroethanes.

The G2 and G2(MP2) quantum mechanical procedures have been used to calculate the enthalpies of formation () of ethylene, acetylene and all of their fluorinated derivatives, $C_2H_xF_{4-x}$, x=0-4 and $C_2H_xF_{2-x}$, x=0-2. Values obtained from both methods exhibit large, systematically negative, deviations from experiment, with errors that increase approximately linearly with the number of C-F bonds. For each method, application of a C-F bond additivity correction, $\Delta_{CF.}$ and heavy atom interaction parameter, , whose values were derived from earlier studies of saturated HFC's, reduced the errors dramatically; the resulting RMS deviations from experiment are lower than the RMS uncertainties in the measured enthalpies. The only reported enthalpy of formation for fluoroacetylene, obtained from average bond enthalpies, has an extremely large uncertainty (> 60 kJ/mol). Based upon the overall good agreement of the calculated heats of formation with experiment, we recommend ΔH_f^o(H-C≡C-F H) = 114 ± 10 kJ/mol.

TRUNCATED BIVARIATE EXPONENTIAL MODELS

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Abstract

Truncated distributions have been the subject of study for many years. But, most of the work done so far involves univariate truncated families. In this study, we consider two different forms of truncated bivariate distributions. Under certain conditions it is shown that one of these distributions has exponential marginal. Method of moments and uniform minimum variance estimators are used to estimate the unknown parameters. We give an estimator of the probability that Y is less than X. Moreover, some graphs are given to compare the fit of the exponential model.

A METHOD FOR STUDYING CHANGES IN TISSUE ENERGETICS RESULTING FROM HYPERBARIC OXYGEN THERAPY

Thomas E. Skinner
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Abstract

This report describes development of a method for obtaining phosphorous (^{31}P) Nuclear Magnetic Resonance (NMR) spectra as a means for studying changes in tissue energetics resulting from hyperbaric oxygen (HBO) therapy. Since the method quantifies direct biochemical measures that are expected to be important in the process of wound healing, it is expected to provide a tool for assessing viability and metabolic activity levels of tissue. The methodology developed is capable of measuring levels of adenosine triphosphate (ATP), phosphocreatine (PCr), phosphomonoesters (PME), phosphodiesters (PDE), and inorganic phosphate (Pi) in human tissue, including in and around wounds. Since the resonance position of inorganic phosphate depends on its state of protonation, ^{31}P NMR can also be used to determine intracellular pH, which is an additional important parameter in wound healing.

INVESTIGATION OF STRUCTURAL DEFECTS IN 4H-SiC WAFERS

Marek Skowronski
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Abstract

Structural defects in silicon carbide wafers have been investigated using optical Nomarski-contrast microscopy, etching in molten KOH, and Auger spectroscopy. Several types of defects have been observed including: inclusions, low angle grain boundaries, micropipes, dislocations, cracks, and polishing scratches. Possible mechanisms responsible for formation of these defects have been proposed.

Smart Structure/Actuator Modeling and Design for the Integrated Ground Demonstration Lab

Joseph C. Slater

1.0 Abstract

The modeling of Ultralight sparse array systems using IMOS (Integrated Modeling of Optical Systems) was studied. Techniques for maintaining model accuracy while decreasing model size (reducing model degrees of freedom) are analyzed. Code has been generated to supplement the capabilities of IMOS. Techniques for the coupling of state space structural systems (systems with common states) in MATLAB were developed. Code for obtaining the observability and controllability matrices of a very large state space system quickly (approximately 350 times faster than the standard MATLAB code) were developed.

BIODEGRADATION OF 2,4-DNT AND 2,6-DNT IN MIXED CULTURE AEROBIC FLUIDIZED BED REACTOR AND CHEMOSTAT

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Environmental Engineering Program
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Abstract

This study examined the aerobic biodegradation of mixtures of 2,4-dinitrotoluene (2,4-DNT) and 2,6 dinitrotoluene (2,6-DNT). A 1.5 L fluidized bed bioreactor with sand (d: 0.425-0.595 mm) as a carrier material was fed a tap water laden with 2,4-DNT and 2,6-DNT at nominal concentrations of 40 and 10 mg/L, respectively. The loading rates to the reactor were gradually increased by increasing the feed flow rate from 0.12 to 1.0 L/hr. Removal efficiencies higher than 99% for 2,4-DNT and 95% for 2,6-DNT were obtained for applied surface loadings of 240 mg/m^2 d 2,4-DNT and 60 mg/m^2 2,6-DNT. Nitro-N was almost stoichiometrically released and mainly measured as nitrate-N in the reactor effluent. Biofilm concentrations in the reactor at the highest loading rate were 2.22 mg COD/g sand (SD 0.11) and 0.65 mg protein/g sand (SD 0.08). Biofilm thickness was estimated at 45.8 μm (SD 1.9 μm). Air scouring during resuspension of settled bed resulted in significant biofilm washout. Respirometric experiments were successfully applied to measure biotransformation of 2,4-DNT and 4-methyl-5-nitrocatechol (4M5NC) by chemostat cultures. A stoichiometry of 3.59 (SD 0.39) and 2.39 (SD 0.22) moles of oxygen / mole of substrate was measured for 2,4-DNT and 4M5NC, respectively. 2,4-DNT removal followed typical Monod kinetics, while 4M5NC removal exhibited strong substrate inhibition kinetics.

BIOREMEDIATION AND ITS EFFECT ON TOXICITY

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Abstract

Bioremediation of petroleum hydrocarbons and its effect on toxicity reduction was investigated through a combination of literature and modeling studies. A literature review was conducted on the biotransformation of petroleum hydrocarbons and microbial metabolite formation under alternate electron acceptor conditions when oxygen is not present. The literature review provided the basis for developing a predictive model of biodegradation of petroleum hydrocarbons under anaerobic conditions. A multispecies energetic/kinetic model of alkylbenzene biodegradation was developed and applied to quantitatively predict toluene mineralization by anaerobic consortia when ferric iron and sulfate were available electron acceptors. Simulations predicted that iron was preferentially used as the electron acceptor when iron- and sulfate-reducing microorganisms were present at equal initial populations.

The chemical properties of specific components of JP-4 and potential microbial degradation products were modeled using structure-based Group Contribution Methods. Metabolite formation from parent compounds generally enhanced water solubility and mobility, suggesting that the concentrations and transport properties of metabolites may be important factors in toxicity and risk reduction assessments. A literature review was conducted on the effects of bioremediation on the reduction of toxicity of soils and groundwaters contaminated with petroleum hydrocarbons. The literature results confirm that bioremediation generally results in a reduction in toxicity as measured by a variety of acute and chronic assays, and that toxicity reduction is often corroborated with the reduction in concentration of specific quantifiable chemical components. The results of this literature and modeling study provide a basis with which to develop follow-up laboratory, field, and modeling studies of bioremediation of petroleum hydrocarbons and its effect on toxicity and risk reduction.

THEORETICAL INVESTIGATION OF PHTHALOCYANINE DIMERS

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Abstract

The feasibility of performing quantum chemistry calculations of the binding energy of phthalocyanine (Pc) dimers as a method for establishing a potential energy surface for calibrating molecular mechanics force fields has been investigated. Calculation of the Pc dimer energy in an offset face-to-face configuration (C_{2h}) with MULLIKEN, a quantum chemistry code designed for efficient SCF and MP2 calculations on workstation platforms, takes approximately 30 IBM RS600 590 CPU hours at the SCF/6-31G* level. Calculation of basis set superposition error, which was found to be important, at the same level takes approximately the same computational effort. Therefore, an SCF potential energy surface, reflecting steric repulsion and electrostatic effects but not dispersion effects, with 30 data points can be determined in approximately 1800 CPU hours. Such a surface can be used to accurately determine repulsion and electrostatic parameters for a molecular mechanics potential energy function. Calculations on a dimer of the smaller but chemically similar azoporphine molecule indicate that MP2/6-31G* energies can be determined with approximately the same amount of computational effort as the SCF energies for the Pc dimer. An energy surface using correlated methods is useful for calibrating dispersion parameters in molecular mechanics force fields.

A STUDY OF APOPTOSIS DURING LIMB DEVELOPMENT

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Abstract

Apoptosis, or programmed cell death, is believed to be an important component in pattern formation during development. Until the last few years, apoptosis could only be identified by histochemical staining followed by a pathologist's diagnosis. This labor intensive process prevented progress in establishing the location of apoptosis during development and mechanisms responsible for apoptosis. The objectives of this study were to 1) refine an automated procedure for detecting cells undergoing apoptosis, and check the reliability of the procedure by comparing it to the histochemical staining procedure, and 2) to describe the location and amount of apoptosis in the developing mouse limb bud after the dam had been treated with all-trans retinoic acid.

The results of objective 1 ware used to draft a manuscript which is included as a part of this report. The abstract and text of the manuscript follows. Currently the manuscript is in internal review in the Toxicology Division of Armstrong Laboratories, Wright-Patterson AFB after which it will be submitted for publication in the *Journal of Histotechnology*. Data collection for objective 2 is still underway, and a collaboration will be continued to complete the project. An abstract of work completed thus far follows the manuscript.

Aging Aircraft: Preliminary Investigation of Various Materials and Process Issues

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Abstract

Initial effort during the AFOSR, eight-weeks, summer program at the Wright Laboratories was to try to identify some of the materials and process issues associated with aging Air Force aircraft. The approach was to review the current literature on aging aircraft, discussing the various topics with engineers from the Materials Directorate and attending the fourth Aging Aircraft Conference held at the USAF Academy. An annotated bibliography was prepared of the pertinent technical literature. Corrosion, nondestructive evaluation of corrosion damage and repair of corrosion damaged structures were identified as major problems. The research opportunities for the Air Force may be to improve inspection, corrosion inhibitions and control, characterization and analysis of aging structures and materials.

Reviewed by: RC Crane
Dr. Robert Crane, WL/ML

Memory-Based Control Methodology with Application to EMRAAT Missile

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North Carolina A&T State University

Abstract

This work investigates a memory-based approach to controlling dynamic systems with significant nonlinearities and uncertainties. The main idea behind the memory-based method is to build the control scheme upon certain memorized information such as current system response, previous system response and past control experience. Fundamentally, the desired control signal in the scheme is "learned" and generated from observing and processing the most recent experience stored in a memory. System performance can be continuously improved during system operation. There is no need to repeatedly run the system for the same task (a process that is not allowed in many practical systems). Another advantage of this approach is that the overall required memory space does not grow with time and is much smaller than most existing learning control methods. The effectiveness of proposed method is verified via simulation on EMRAAT missile.

Integrating a Multimedia Database and WWW Indexing Tools

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State University of New York
Institute of Technology at Utica/Rome

Abstract

The dropping cost of computing and data communication has lead to rapidly growing data networks. Production systems are evolving to include access to on-line multimedia information while powerful workstations replace character terminals. Exploiting the modern environment requires easy user-level access and an architecture that facilitates data integration. This paper describes an architecture which features WWW indexing tools that extend the functionality of distributed relational databases. It provides access through standard HTML-based WWW browsing tools to multiple databases. The resulting distributed system is capable of growth and is accessible world-wide.

MICROSTRUCTURAL DEVELOPMENT DURING HOT DEFORMATION

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Abstract

The microstructure of a material during hot working depends upon the processing conditions, such as state of stress, strain, strain-rate, and temperature, during deformation. A new strategy for microstructural control using modern control theory and state space models for describing material behavior has been developed at the Process Design Branch (WL/MLIM). Experimental studies were conducted to validate this new strategy using hot extrusion of AISI 1030 plain carbon steel.

In another phase of research, microstructural development during hot deformation of 304L stainless steel was initiated. This alloy has wide applicability in chemical and metallurgical industry where toughness and high temperature corrosion resistance is required at high temperatures. Samples of 304L had been previously deformed by press forging, extrusion, and rolling over a wide range of temperatures (600 to 1200°C) and strain rates (0.001 to $100 s^{-1}$) to a strain of 0.7. Transmission electron microscopy (TEM) of the deformed samples was initiated in order to clearly identify the various microstructural processes (dynamic recovery, dynamic recrystallization, twinning, etc.) that occur during deformation.

CMOS MODELING OF TOTAL DOSE RESPONSE OF SOI N-MOSFETS FOR LOW POWER CMOS CIRCUITS

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Abstract

In the present work, we have developed an integrated and flexible rad-sensitive subthreshold model for the partially depleted, SOI n-channel MOSFETs based on existing pre-irradiated device models for applications in low power CMOS circuit designs. The radiation-induced oxide trapped charge and interface state charge are integrated in the charge-sheet model of the MOSFET. The model is continuous from subthreshold to strong inversion regions, with floating body effects, and associated parasitics such as BJT included. To demonstrate the applicability of the model, we have predicted subthreshold current-voltage characteristics of a typical SOI n-MOSFET under a total dose condition in linear region of shift in threshold voltage versus dose. The predicted shift of subthreshold characteristics to more negative values with dose with respect to pre-irradiated condition agrees with the experimentally observed behavior reported in literature.

JOINT CORRECTIONS FOR CORRELATION COEFFICIENTS

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Abstract

Corrections for range restriction and unreliability are common in psychometric work. Current methods for applying these corrections jointly fail to take into consideration the potentially harmful impact one correction has on the conditions necessary for making the other correction. Using classical test theory, we derive new joint correction formulas that avoid this problem and show how joint correction as currently practiced is sometimes inappropriate.

Studies to Identify Characteristic Changes in the Urine Following Ingestion of Poppy seed

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Abstract

Characteristics of poppy seed that could be used to differentiate the urine resulting from intake of poppy seed from opiate abuse were studied. Meconic acid which is present at 2-13% in opium was not found in the black or white poppy seed studied. Opiate alkaloids other than morphine and codeine were not identified in the urine following poppy seed ingestion. Chronic multiple ingestion of low doses of poppy seed was found to increase the morphine and codeine content of the urine 2-3 fold over single ingestion. The morphine/codeine ratio in chronic and acute ingestion of poppy seed had a range of 4-13 with relatively low variation within individuals. The morphine/codeine ratio appears to provide a tool which may be useful in differentiation of poppy seed consumption from opiate abuse.

THE POTENTIAL APPLICATIONS OF SUPER-RESOLUTION AND ARRAY PROCESSING TO SPACE-BASED RADARS

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Abstract

To justify placing a radar in space, the sensor must exhibit high performance over a number of radar modes, yet provide these goals with a sensor small and light enough to be economically placed in space. To achieve this, a sensor with increased hardware complexity and computational power is likely required. By designing the receive aperture as an instrument for collecting both power and information, the potential exists to collect sufficient information to provide high-resolution detection of targets, whether stationary and moving, airborne or on the earth's surface. Additionally, larger area search rates than provided by conventional radars can be obtained. This is achieved by implementing multiple apertures and sub-apertures as the receive antenna, the output of each independently and coherently sampled. This volume of data provides an extreme amount of information, and can be used to implement such functions as digital beamforming and super-resolution.

APPLICATION OF META-ANALYSIS TO RESEARCH ON PILOT TRAINING: A CASE STUDY OF RESEARCH ON SIMULATOR SCENE CONTENT AND LOW-LEVEL FLIGHT

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Abstract

This paper reports a meta-analysis conducted of primary research that: (1) examined relations among scene content variables and behaviors relevant to low-altitude flying, and (2) was conducted under the auspices of Armstrong Laboratory. A total of 33 primary research reports were identified using bibliographies available at the Armstrong Laboratory Library. Of these 33, 28 were accessible during the period of this Summer Faculty Research Program. A total of 105 effect sizes were extracted from seven different sources. The average value of these effect sizes was .85; a value that indicates a high degree of positive influence of the manipulations of scene content that were employed in these studies. Based on a global evaluation of this small domain of research studies, a number of recommendations are offered for improving research reporting.

ENGAGEMENT, INVOLVEMENT, AND SELF-REGULATED LEARNING: CONSTRUCT AND MEASUREMENT DEVELOPMENT TO ASSESS ACHIEVEMENT AND CALIBRATION

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Abstract

In order to determine ways to develop better evaluation of student learning and to design better educational tools to enhance student learning, the areas of student engagement, involvement, and self-regulated learning were thoroughly reviewed. It was discovered that engagement, involvement, and self-regulated learning were related, yet somewhat different areas of research related to student learning. Because these research areas had some overlap in terminology, the constructs of engagement, involvement, and self-regulated learning were clarified. Furthermore, it was determined that these three constructs were related to student achievement. Although untested, it is likely that there is also a relationship between these three constructs and calibration. In order to test these relationships, though, a reliable and valid measure is required. Unfortunately, most researchers tend to develop their own scales which are specific to their research project. This implies that there are no common measures and construct validity is limited. Hence, measurement items for engagement, involvement, and self-regulation were developed. Finally, research was proposed to test the reliability and validity of these measures, to determine the relationship between these measures and student achievement and calibration, and to evaluate ways to increase students' levels of engagement, involvement, and self-regulated learning. Knowledge gained from the proposed measures and research will be extremely beneficial in determining which students possess the skill or attitude to succeed, what teaching or training designs are needed to enhance student engagement, involvement, and/or self-regulated learning, and how to increase student calibration.

ON MULTIOBJECTIVE FUNCTION OPTIMIZATION IN ENGINEERING DESIGN

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Abstract

As mathematical optimization methodologies become more and more accepted in the various areas of engineering, the complex problems at hand often require multicriteria or multiobjective function optimizations since most real-life design or decision problems involve multiple and conflicting objectives and constraints. In order to decrease the complexity of such optimizations, it seems of interest to investigate how the various objectives and constraints of a given problem influence and complement each other. Such knowledge could reduce the number of objectives and constraints by eliminating from the optimization loosely coupled parameters. In the present approach, various scenarios were developed, and studies in mathematical, structural, aircraft performance, and aircraft multidisciplinary design optimization were suggested to address these issues. Investigations in structural and aircraft multidisciplinary design optimization were initiated.

Additional MDO issues were addressed during the course of the summer. They are presented in Appendices at the end of the report.

APTITUDE-ATTRIBUTE INTERACTIONS IN TEST PERFORMANCE

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Abstract

This study examined the extent to which test performance is jointly influenced by attributes of test items and general aptitude of test takers. A methodology was developed for coding item attributes and simultaneously analyzing aptitude-attribute, attribute-attribute, and main effects. Pretest and posttest data from a previous study were reanalyzed using this methodology. A number of aptitude-treatment interactions and attribute-attribute interactions were found. For example, on the posttest, the lower one's level of general ability, the lower one's performance on items requiring generation of responses, compared to performance on items requiring selection of responses. Regardless of aptitude, items requiring symbolic knowledge were easier in selection format than in generation format, whereas items requiring procedural skill were (at least on the posttest) equally easy regardless of format. The existence of such interactions means that conclusions about item difficulty based only on main effects may be misleading.

Confined Optical Phonon Modes in Si/ZnS Superlattices

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ABSTRACT

The confinement of optical modes of vibrations in a superlattice consisting of polar and nonpolar materials is described by a continuum model. Specifically, the structure under investigation is the Si/ZnS superlattice. Optical phonon modes in Si and ZnS layers are totally confined within their respective layers since both layers can be treated as infinitely rigid with respect to the other layer. Since there are no associated electric fields with nonpolar optical phonons in Si layers, only mechanical boundary condition needs to be satisfied for these nonpolar optical modes at the Si-ZnS interface. The optical phonons in Si layers can be described by guided modes consisting of an uncoupled s-TO mode and a hybrid of LO and p-TO modes with no interface modes. In ZnS layers, a continuum model hybridizing the LO, TO and IP modes is necessary to satisfy both the mechanical and electrostatic boundary condition at the heterointerface. A numerical procedure is provided to determine the common frequency between LO, TO, and IP modes. Analytical expressions are obtained for the ionic displacement and associated electric field as well as scalar and vector potentials. These expressions can be employed directly in calculating the carrier interaction with optical phonons in the superlattice.

Balloon Launch Retromodulator Experiment

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Clarke Steed
Graduate Student
Utah State University

ABSTRACT

Under the AFOSR summer research program researchers from Utah State University / Space Dynamics Lab spent 12 weeks at the Phillips lab preparing and flying a retromodulator laser communication package on a high altitude balloon. The package was a prototype system for a low-power laser communications system for small low earth orbiting satellites. The work was divided into preparation of the ground station at Starfire Optical Range, assembly and testing of the retromodulator control electronics, micro controller programming and the actual balloon flight of September 15, 1996. All technical objectives of the experiment were met during the 1 1/2 hour flight of the balloon which reached a float altitude of 103,000 ft. The ferroelectric liquid crystal based retromodulator design of Utah State provided test patterns for modulation rates up to 20 kilo bits. Data was successfully down linked using a 1200 bps RS232 format and a simplistic receiver. This report outlines some of the reflected laser communications activities conducted under this summer research program.

OPTICAL AND ELECTRO-OPTICAL STUDIES OF POLYMERS

Abstract

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The Physics Group routinely performs room temperature absorption and photoluminescence (PL) measurements on polymers synthesized within the Polymer Branch of Wright Laboratories. These routine measurements were supplemented by a temperature dependence study of the PL of the polymer 6F-PBO over the temperature range of 110 to 365 K. 6F-PBO is a member of the polybenzoazoles with 6F moieties in the form of alkoxy pendants ($OC_{10}H_{21}$). The results indicate a thermally activated quenching of the PL with an activation energy of 109 meV. The individual PL spectra were deconvoluted by means of nonlinear least square analysis. Three gaussian peaks provided an excellent fit to the spectra at all temperatures. Attempts to perform complementary optical absorption measurements in the band-tail region over a similar temperature range were inconclusive due to experimental difficulties that have been identified, but have not yet been overcome.

EFFECTS OF AIRBLAST CHARACTERISTICS ON STRUCTURAL RESPONSE

Joseph W. Tedesco
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Abstract

The use of smaller munitions by Air Force aircraft for attacks on fixed hard target threats is receiving serious consideration. Presumably, the motivation for this action is to increase aircraft loadout, thus permitting a greater number of targets that can be destroyed in a single sortie. A major concern with the smaller munmitions is their effectiveness in delivering a warhead having a blast impluse capable of destroying the majority of the fixed hard target threats. This report summarizes the results of a preliminary analytical study to assess the defining characteristics of an airblast on the structural response of a predefined hard target. The results of the investigation indicates that the structural response of the target to a specific impulse is significantly influenced by the airblast peak pressure, duration of the positive pressure phase and shape of the pressure-time curve.

SUBCRITICAL CRACK GROWTH OF Ti-6Al-4V UNDER RIPPLE LOADING CONDITIONS

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University of Notre Dame

Abstract

Recent premature failures of some titanium alloy fan blades and disks in various military and commercial jet engines have been attributed to high cycle fatigue (HCF). The rotating components in jet engines experience "ripple loading"; that is, high frequency, low amplitude vibratory loads superposed on large, slowly varying "centrifugal" loads. An investigation of the influence of ripple-loading on subcritical crack growth of a mill-annealed Ti-6Al-4V titanium alloy was the object of this summer research. Experiments to characterize the: 1.) sustained load cracking threshold, $(K_{th})_{slc}$; 2.) the SLC growth rate as a function of K; and 3.) the fatigue crack growth threshold at high R-ratios, ΔK_{th} were started. Testing preliminaries were completed. A d.c. potential drop-crack length calibration relationship was obtained using the data from two specimens along with initial estimates for $(K_{th})_{slc}$. The testing is being continued by WL/MLLN scientists.

THE EFFECTS OF CURVATURE ON THE PERFORMANCE OF A SPIRALLY-GROOVED COPPER-ETHANOL HEAT PIPE

Scott K. Thomas
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Wright State University

Abstract

Heat pipes are simple, effective devices which are capable of transporting heat energy from one location to another with a very low superheat penalty. Heat pipes have become excellent candidates for passive cooling of high performance aircraft. Due to high transient acceleration fields present in such applications, heat pipes must be able to operate effectively under adverse conditions. In an effort to understand heat pipe performance under transient acceleration fields, a two-phase study is being conducted. Phase 1 included the design, fabrication and testing of a spirally-grooved copper heat pipe with ethanol as the working fluid. The heat pipe was tested horizontally for the capillary limit before and after being bent to a radius of 1.22 m along the centerline of the pipe, which provided information into the effects of curvature on the heat pipe performance. During Phase 2, the transient response of the curved heat pipe will be examined on a centrifuge table with a 1.22 m radius. The centrifuge table will be able to vary the radial and tangential velocities in a sinusoidal manner as a function of time with varying frequency. By operating the centrifuge table in this manner the acceleration fields produced by high performance aircraft can be approximated. This report describes the experimental procedures and results determined during Phase 1.

Grid Level Parallelization of an Implicit Solution of the 3D Navier-Stokes Equations

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Abstract

A parallel version of the FDL3DI application from Wright Laboratory was developed using MPI on a Cray T3D. This report describes the parallel Chimera version of FDL3DI which solves the three-dimensional Navier-Stokes equations for multiple overlapped grids. A simple approach to parallelizing the Chimera method is taken. Each grid is assigned to a separate processor and the interpolated boundary points are exchanged between processors as necessary. This approach requires few modifications to the source and relatively little communication between processors.

The execution time for an 8 grid flow problem was only 1.6 times greater on eight processors of the T3D than on a single processor of the Cray C916 vector processor. These preliminary results on the T3D demonstrate that parallel systems are competitive with the Cray vector systems for this application.

QUALITATIVE PROCESS MODELING OF CELL-CYTOKINE INTERACTIONS. ADHESION MOLECULES, AND GENE REGULATION IN IMMUNITY, INFECTION AND WOUND HEALING

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UCLA School of Medicine

Abstract

The theories and applications of artificial intelligence and qualitative process modeling methodologies were studied in the contexts of cell interactions, cytokines, cell adhesion molecules, and gene regulation processes involved in innate immunity and hyperbaric oxygenation. The principal objective was to develop modeling systems capable of representing basic research experiments, medical treatment processes and outcomes for the purposes of evaluating real experimental data and recursively generating new process rules to extend the existing knowledge base heuristics. System heuristics were successfully created for representing cell interactions, cytokines, adhesion molecules, and gene regulation in immunity, infection and wound healing, and the operations of fundamental qualitative process models were demonstrated in a number of successful simulation experiments.

MECHANICAL SPECIALTIES IN THE U.S. AIR FORCE: ACCESSION QUALITY AND SELECTION TEST VALIDITY

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Abstract

The current study examined whether there has been a decline in mechanical abilities among airmen in Mechanical Air Force specialties (AFSs) and whether the Mechanical portion of the Armed Services Vocational Aptitude Battery (ASVAB) is a valid predictor of mechanical performance among those specialties. The records of 48,009 first-term recruits who enlisted in the service between January, 1990 and September, 1995 and were assigned to a Mechanical AFS were examined. Results indicated that the level of mechanical performance among those recruits selected for Mechanical specialties has remained stable. The Mechanical portion of the ASVAB appears to be a valid predictor of performance during technical school training. An explanation for these findings is discussed and other factors to improve the prediction of mechanical performance are considered.

REGULARIZATION METHODS
FOR LINEAR AND NONLINEAR RETRIEVAL PROBLEMS

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Abstract

Retrieval of atmospheric and surface characteristics, such as atmospheric temperature and water vapor content, from remotely sensed data is at the heart of applications in meteorology, atmospheric, oceanography, and geophysical sciences. The relation between features of interest and the measured radiance is given by the radiative transfer equation. The retrieval problem is then equivalent to the inversion of the radiative transfer equation. Many of these inversion problems are ill-posed and therefore regularization techniques are needed to convert the retrieval problem into a well-posed problem that can be numerically solved. In this report, some results regarding the application of regularization techniques to the temperature retrieval problem from microwave radiometry near O_2 absorption band at 60 GHz are presented. Results show that regularization methods can be capable of determining the tropopause height independent of the initial guess with need of minimal prior statistical information about sensor noise and profile distribution.

SIMULATION OF ANTI-JAMMING GPS ARRAYS USING FINITE ELEMENT SOFTWARE

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Abstract

Two sophisticated anti-jam antennas explicitly designed for the Global Positioning System (GPS) satellite communications were simulated and analyzed using the University of Michigan finite element software FEMA-PRISM. The software was upgraded to allow simulation of these unique GPS antenna arrays which consisted of a reference element and an array of six anti-jam auxiliary elements that produce pattern nulls at the direction of the incoming jamming signal. The goal of the study was to examine the effectiveness of current state-of-the-art software for simulating complex antenna arrays and to generate accurate volumetric patterns (incorporating mutual coupling, losses, dispersion, etc.) of the actual array to be used in a hardware simulator when evaluating the anti-jam performance of the antenna array under test. Our study demonstrated that the University of Michigan finite element code FEMA-PRISM with (minor modifications) was capable of analyzing the two GPS antennas without compromising their geometrical features in performing the numerical analysis. For one of the arrays, the antenna element was a slot backed by a triangular cavity whereas for the second array the basic element was a dual patch to accommodate radiation at the L1 (1575 MHz) and L2 (1227 MHz) GPS bands. Patterns and input impedance curves were generated for each antenna and these were validated with reference data whenever possible. With the availability of the simulation models and discrete geometry data for each antenna, future efforts will focus on evaluating the performance of the arrays under various jamming conditions and realistic GPS operational scenarios.

AN EXPERIMENTAL AND COMPUTATIONAL ANALYSIS OF THE INFLUENCE OF A TRANSONIC COMPRESSOR ROTOR ON UPSTREAM INLET GUIDE VANE WAKE CHARACTERISTICS

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J. Mitch Wolff
Assistant Professor

Department of Mechanical and Materials Engineering
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Abstract

Gas turbines are a vital energy source for both industrial and military applications. Recent research has focused on identifying the unsteady flow mechanisms inherent in gas turbines. A progress report is given of a research study utilizing both a computational analysis and experimental tests on the unsteady aerodynamic effect of a downstream transonic compressor rotor on the upstream inlet guide vane/stator wakes. This study should show that the wakes coming off of the upstream stators are significantly affected by the unsteady action of the transonic rotor with its inherent shocks. Currently, design codes do not consider the unsteady aerodynamic effects of the rotor/stator interaction. The purpose of this current study is: (1) experimentally determine if the inlet guide vane surface pressures are changed and gain insight into the driving unsteady aerodynamic processes (2) computationally model the experimental configuration using a nonlinear unsteady multi blade row Navier-Stokes code, identify model weaknesses and make improvements to the unsteady turbomachinery computational code. This report describes the experimental setup and the computational method selected.

INTEGRATED AEROELASTIC SMART STRUCTURE CONTROL USING ACCELERATION MEASUREMENT FEEDBACK

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Abstract

In the research during the Summer Faculty Research Program, the aspect of designing control systems for controlling a composite plate structure subject to aeroelastic loading using piezoelectric actuators and sensors and acceleration measurements was studied and new controller designs are developed. The nature of the sensing variables and the distributed nature of smart material actuation and sensing is exploited and accommodated in the control design algorithms. The controllers designed include a state estimate based feedback as well as a pure measurement feedback using various measurements related to motion variables such as accelerations, velocities and displacements. The proposed methods provide different norms for estimator and controller gains, thereby allowing more flexibility in gain magnitudes and selection of sensors. Then the controller gains and the structural weight are optimized by using integrated structure/control optimization schemes. Finally, preliminary designs are initiated for active flight control with smart deformable wing structures.

A FOURTH-ORDER, TIME-DOMAIN ALGORITHM
FOR MAXWELL'S EQUATIONS

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Abstract

A compact, central–difference approximation, in conjunction with the Yee grid, is used to compute the spatial derivatives in Maxwell's equations. To advance the semi–discrete equations, the four–stage Runge–Kutta integrator is invoked. This combination of spatial and temporal differencing leads to a scheme that is fourth–order accurate, conditionally stable and highly efficient. Moreover, the use of compact differencing allows one to apply the compact operator in the vicinity of a perfect conductor – an attribute not found in other higher–order methods. Results are provided that quantify the spectral properties of the method. Simulations are conducted on problem spaces that span one and three dimensions and whose domains are of the open and closed type. Results from these simulations are compared with exact, closed–form solutions; the agreement between these results is consistent with numerical analysis.

VALIDATION OF THE DEFORMABLE NECK MODEL FOR A +Gz ACCELERATION

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Abstract

During the ejection phase of escape, crew members are susceptible to neck injuries. Testing and computer simulations with the Articulated Total Body (ATB) computer program have been used to evaluate the effect of acceleration levels on human body response during ejection procedures. The objectives of this study were to create finite element neck models for several Vertical Drop Tower (VDT) test subjects to be incorporated into the deformable neck option of the ATB computer model and to assess the accuracy of the ATB model with the deformable neck option in predicting human response in the catapult phase of an ejection. The experimental data used in this study were collected from the biodynamic responses of human volunteers during an acceleration in the z-direction on the Vertical Drop Tower facility at Armstrong Laboratory at WPAFB. The experiments were performed for an approximate maximum acceleration of 10 G's for the male subjects and 8 G's for the female subject; the subjects were not wearing helmets. Data from twelve male and one female subjects were used for this study. A three segment model including the upper torso, neck and head was used. Head acceleration data at the mouth piece location and at the center of gravity location were calculated. The simulation results with the experimental data and, for reference purposes, the experimental chest acceleration data that were used as input into the ATB model were presented.

The ATB simulations using the current deformable neck option predict well the head acceleration in the x-direction which represents head rotation, however, they underestimate the maximum acceleration in the z-direction by up to 30%. Data from the analysis indicated that the location of the mouth piece on the subject is an important factor affecting the accuracy of simulation. The precise position of the test subject's head at the time of the impact could also affect the accuracy of simulation. It is anticipated that the neck load from the deformable neck option would provide a reasonable bending torque and would underestimate the compression load by 10 to 30 %.

DEVELOPMENT OF A GLOBAL NAVIGATION SATELLITE SYSTEM SOFTWARE RADIO

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Abstract

A preliminary Global Navigation Satellite System (GNSS) software radio was developed. A software radio has many advantages over the architecture of a traditional receiver. These include a tighter integration between simulation and implementation, a tremendous level of versatility in the final design, and the ability for a single receiver to function as multiple receivers. The key elements for the development of a software radio are analog-to-digital converter (ADC) technology and programmable processing power. Both of these issues have been investigated. The focus of this implementation, a GNSS receiver, is a navigation receiver and will bring all the benefits of the software radio to the navigation community. The preliminary work accomplished in the development of the GNSS software radio is the implementation of the receiver front end, data collection hardware, and data processing algorithms.

TESTING THE FROZEN SCREEN MODEL OF ATMOSHPERIC TURBULENCE AND AN INTERFEROMETER DESIGN FOR MEASURING ATMOSPHERIC TURBULENCE NEAR GROUND LEVELS

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Abstract

Atmospheric turbulence is responsible for scattering of the light that makes it's way through the atmosphere and therefore deteriorates the observations being made by any astronomical instrument. This study designs a triple coincidence experiment to test the frozen screen model of atmospheric turbulence and determine if we can put in place an interferometer or equivalent system that will measure the atmospheric turbulence in the near field. Various types of interferometers have been considered including the Fabry - Perot and the Mach - Zehnder arrangements. Other design considerations include the path lengths necessary for detection of small changes in the index of refraction of air. light sources and positioning of the interferometer.

The "frozen" screen model is to be tested to determine if it can be used as a predictive tool. If the turbulent disturbances travel as a frozen screen it should be possible to sample them upstream of a telescope and apply corrections in real time; or if this is not possible then downstream of the telescope for post detection corrections. We propose to build an 'Amato' (one arm in vacuum) Mach-Zehnder type interferometer with physically coupled arms that expand and contract together to null any pathlength changes in the system due to changes in the apparatus. This is to insure that all phase shifts in the fringe pattern are due to changes in the index of refraction of the air in the open arm, see section *. We propose to use two identical setups in an upwind/downwind configuration and check for time delayed coincidences in the fringe patterns. In parallel we propose to run a very high resolution Fabry-Perot Interferometer and very sensitive Microbarograph and do similar coincidence studies to see if any or all methods are useful in detecting and predicting atmospheric fluctuations.

COMPUTER MODELING
OF STRUCTURAL FAILURE

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Abstract

Several computer codes were evaluated that predicted failure from either buckling and/or damage such as cracks and delaminations. The Knowledge Systems Inc.(KSI) BuckDel computer program performs buckling analysis of laminated composite shell structures with delaminations in order to determine the remaining strength. Also, the KSI phase II SBIR proposal was evaluated. This proposal would incorporate damage tolerance analysis software into the Automated Structural Optimization Systems (ASTROS) software. The ASTROS V12 computer program combines mathematical optimization routines with classical structural analysis software and was recently modified to include panel and column buckling capabilities. The ASTROS panel and column buckling analysis performed well when compared to handbook solutions but could only be used separately. The panel and column buckling capabilities in ASTROS could not be used at the same time. Buckling constraints were used in ASTROS to optimize the design of a simple aircraft wing for minimum weight. Later, fatigue crack damage tolerance constraints were applied to the simple aircraft wing and the ASTROS optimization resulted in a weight increase of 49%. Finally a p-element finite element code called Mechanica was evaluated on a two cell beam and on a simple aircraft wing. Static and modal analyses were compared between ASTROS and Mechanica with mixed results.

A FAST FOURIER TRANSFORM ANALYSIS OF PILOT INDUCED OSCILLATIONS

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Abstract

During the summer of 1996 a program was initiated by the authors to study the characteristics of pilot induced oscillations (PIOs). The long term goals are

- to develop a methodology to take time history data from flight or ground based simulation and determine if a vehicle is PIO prone,
- to determine if a PIO actually occurred in a time history record,
- to develop a non-real-time analysis tool to determine from flight simulator time history data if PIOs occurred so that simulation engineers can help insure consistency between pilot comments, Cooper-Harper ratings, PIO ratings and time history data, and
- to develop a real-time capability of detecting a PIO fast enough to take action to prevent the full development of the PIO.

Results obtained over the period 7/1/96-8/23/96 deal primarily with the first goal and are described in this report. A computer analysis tool is developed in which fast fourier transforms are used to determine

- resonant frequency and output phase angles at the resonant frequency,
- predictions of PIO susceptibility using the Smith-Geddes PIO criteria.

The following preliminary results are highly encouraging.

- 13 of 14 configurations which experienced PIOs were correctly identified.
- In 12 additional configurations 6 were correctly identified as being not PIO prone. Results for the remaining 6 configurations were complicated by multiple resonances that confuse the resonance detector. However, depending on the choice of resonant frequency the correct classification is made for each of the 6 configurations.
- The occurrence of multiple resonances is closely associated with configurations that are not PIO prone.
- continued development of the resonance detector is planned.

DEVELOPMENT OF A USER-FRIENDLY COMPUTER ENVIRONMENT FOR BLIND SOURCE SEPARATION STUDIES

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Abstract

This paper discusses the design of a digital array signal processing environment, geared toward investigations in blind source separation techniques. The system integrates the interactive numerical processing capabilities of Math Works' MATLAB[1] with multichannel data acquisition, and signal processing hardware. A user-friendly graphical user interface, utilizing MATLAB's graphical programming features, facilitates analysis of data, evaluation of algorithms, and modular addition of hardware/software components.

SYNTHESIS OF NOVEL THIRD ORDER NONLINEAR OPTICAL MATERIALS

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ABSTRACT

Synthesis of third order nonlinear optical (NLO) polymers represents an exciting field with the resulting chromophore containing materials being used for two-photon-pumped upconverted lasing or as optical limiters. In this research, three novel NLO chromophores are developed by incorporating a fluorene molecule in their backbone with either thiophene and pyridine end groups which act as electron donating or withdrawing groups respectively. Long alkyl chains are attached to the C-9 carbon on the fluorene backbone to aid in the chromophore's solubility in the host polymer.

MODELING OF ORGANOHALIDE REACTIONS
IN AQUEOUS B12 / Ti(III) SYSTEMS

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Abstract

Development of a kinetic model for the reaction of various organohalides with vitamin B12 and titanium citrate in an aqueous headspace system was attempted. The experimental procedure was simplified using a head space analysis, therefore, all data acquired for model calibration were in total mass per vial concentration units. The parent compound, Perchloroethylene (PCE), was observed experimentally to follow the expected reaction pathway through trichloroethylene (TCE) to the dichloroethenes (DCE) to vinyl chloride to ethylene and finally to ethane. In addition to this, it is proposed that reductive beta elimination is also a mechanism of this reaction due the observed production of acetylene and chloroacetylene(1). Beginning with the outer most limbs of this complex web of pathways, i.e., reactions of acetylene or vinyl chloride to ethene, kinetic constants were determined and fixed. Progress was made up to the root parent, PCE. The model simulates the data well and lends further insight into the true nature of the reaction. The proposed mechanism

$$S + B \underset{k_2}{\overset{k_1}{\leftrightarrows}} SB$$

$$SB + TC \xrightarrow{k_3} P + B$$

accounts for a complexation rate, k_1, and a decomplexation rate, k_2, where S is the substrate, B is the concentration of B12, SB is the substrate/B12 complex, TC is the concentration of titanium citrate, P is the product formed and k_3 is the forward reaction rate constant of SB with Ti(III).

Further progress was made into the development of a model for just the aqueous phase reaction. That is, the model itself incorporates a correction factor based upon dimensionless Henry's constants, K_h'. Given the respective K_h' s of each substrate and product, along with the aqueous and gaseous volumes of the reaction vessel, the model can simulate the reaction progress once the kinetic parameters are properly fitted. It appears that a correction factor must be applied to all rate constants except for the forward complexation rate, k_1.

PROBING THE UNIQUE PROPERTIES OF A SUPERCRITICAL FLUID: FLUORESCENCE RADIATIVE RATE CONSTANT DEPENDENCE ON SUPERCRITICAL FLUID DENSITY, AND BIMOLECULAR QUENCHING EFFICIENCIES AS OBSERVED BY FLUORESCENCE LIFETIME MEASUREMENTS IN SUPERCRITICAL CARBON DIOXIDE

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Abstract

1. The dependence of the fluorescence radiative rate constant k_F of the model fluorophors 9-cyanoanthracene, 9,10-diphenylanthracene, and anthracene on the reduced density and refractive index of supercritical carbon dioxide at 35 °C is investigated. Fluorescence lifetimes are determined using the time-correlated single photon counting method. The k_F results support previous studies demonstrating anomalous behavior in the low density regions of a supercitical fluid, and indicate a strong system dependence. 9-cyanoanthracene and 9,10-diphenylanthracene both display an unusual behavior of k_F in the low density region of supercritical carbon dioxide, while anthracene results agree well with radiative rate theory. 2. The quenching of 9-cyanoanthracene, 9,10-diphenylanthracene, anthracene, and perylene fluorescence by carbon tetrabromide is investigated in supercritical carbon dioxide as a function of density. Fluorescence lifetimes of the model fluorophors at different carbon tetrabromide concentrations are determined. The fluorescence decays adhere closely to single-exponential functions and the carbon tetrabromide concentration dependence follows the Stern-Volmer relationship. The quenching of the fluorescence lifetime for 9-cyanoanthracene and 9,10-diphenylanthracene is unusually efficient at near-critical densities. The results are in support of a solute-solute clustering mechanism in which the enhance bimolecular reactions are attributed to a higher local quencher concentration then the bulk under near-critical solvent conditions. At the same time, the quenching of anthracene and perylene display no unusual behavior and are apperently diffusion controlled throughout the density region examined.

STUDY OF PERIOD DOUBLING BIFURCATIONS IN A LOSS AND PUMP MODULATED SPECIALLY CONSTRUCTED ND:YAG LASER

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Abstract

A simple Neodymium-doped Yttrium-Aluminum-Garnet (Nd:YAG) laser was constructed, and its behavior studied. The objective of this project was to drive a solid-state laser, with single longitudinal and transverse modes, into a chaotic state and to map the period-doubling route to chaos. In order to achieve these characteristics, a very short laser cavity was employed, and an acousto-optic modulator was aligned inside the laser cavity. The simplicity of this laser configuration allows comparisons between experimental test results and theoretical models, which are ineffective for laser systems with many modes, due to the required complexity of a model for such a system.

IDENTIFICATION AND EVALUATION OF LOSS AND DEVIATION MODELS FOR USE IN COMPRESSOR STAGE PERFORMANCE PREDICTION

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Abstract

Simulations to model the compressor, a component of the gas turbine engine, have been developed to augment ground and altitude testing at AEDC. The models are based upon the conservation principals of continuity, momentum, and energy. To provide closure for these equations, a set of stage characteristics are required to capture the physics of the compressor since the blades have been replaced with semi actuator disk theory. Correlations of cascade experimental data is one method used to obtain these characteristics. These correlations specify pressure loss and flow turning caused by the blade. Current correlations used in the streamline curvature codes are inadequate for high speed transonic axial compressors. The objective of this project is to investigate and evaluate correlations available and ultimately discover sets of correlations which best fit the empirical data to be used in a streamline curvature code.

Dose-Response of Retinoic Acid-Induced Forelimb Malformations as Determined by Image Analysis

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Abstract

Exposure of gestation day 11 mouse embryos to exogenous all-*trans* retinoic acid (RA) results in altered bone development and pattern formation in the limb. The dose-response curve for specific limb malformations remains poorly characterized, a potential impediment to quantitative risk assessment. Therefore, pregnant CD-1 mice were administered a single oral dose of RA (0, 2.5, 10, 30, 60, and 100 mg/kg) on gestation day 11, and day 18 fetuses were examined for forelimb malformations using computerized image analysis. Dose-dependent changes occurred in the size and shape of the scapula, humerus, radius, and ulna, with no effect on the digits. Multiple descriptors of bone size and shape indicate 10 mg/kg to be a near threshold dose for malformations, while 100 mg/kg results in severe alterations in bone size and shape in virtually all forelimbs. By utilizing image analysis to characterize RA-induced forelimb malformations over a broad range, an extremely detailed and highly quantitative analysis of the dose-response relationship was made.

SIMULATION OF ANTI-JAMMING GPS ARRAYS USING FINITE ELEMENT SOFTWARE

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Abstract

Two sophisticated anti-jam antennas explicitly designed for the Global Positioning System (GPS) satellite communications were simulated and analyzed using the University of Michigan finite element software FEMA-PRISM. The software was upgraded to allow simulation of these unique GPS antenna arrays which consisted of a reference element and an array of six anti-jam auxiliary elements that produce pattern nulls at the direction of the incoming jamming signal. The goal of the study was to examine the effectiveness of current state-of-the-art software for simulating complex antenna arrays and to generate accurate volumetric patterns (incorporating mutual coupling, losses, dispersion, etc.) of the actual array to be used in a hardware simulator when evaluating the anti-jam performance of the antenna array under test. Our study demonstrated that the University of Michigan finite element code FEMA-PRISM with (minor modifications) was capable of analyzing the two GPS antennas without compromising their geometrical features in performing the numerical analysis. For one of the arrays, the antenna element was a slot backed by a triangular cavity whereas for the second array the basic element was a dual patch to accommodate radiation at the L1 (1575 MHz) and L2 (1227 MHz) GPS bands. Patterns and input impedance curves were generated for each antenna and these were validated with reference data whenever possible. With the availability of the simulation models and discrete geometry data for each antenna, future efforts will focus on evaluating the performance of the arrays under various jamming conditions and realistic GPS operational scenarios.

THE DESIGN AND CHARACTERIZATION OF NOVEL P-TYPE QUANTUM WELL INFRARED PHOTODETECTOR STRUCTURES BASED ON III-V MATERIALS FOR MID- AND LONG-WAVELENGTH INFRARED DETECTION

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Abstract

The design and characterization of a p-type compressively strained-layer (PCSL) InGaAs/AlGaAs/GaAs quantum well infrared photodetector (QWIP) grown on a (100) semi-insulating (SI) GaAs substrate has been performed. The detector is a stacked QWIP which is designed to be sensitive in both the mid- (MWIR) and long-wavelength (LWIR) infrared bands. The MWIR stack is composed of a PCSL $In_{0.2}Ga_{0.8}As/Al_{0.3}Ga_{0.7}As$ QWIP with a detection peak at λ_p =4.8 μm, while the LWIR stack is based on a PCSL $In_{0.15}Ga_{0.85}As/Al_{0.1}Ga_{0.9}As$ QWIP with a detection peak at $\lambda_p = 10$ μm. The peak responsivity of the LWIR QWIP was found to be 25 mA/W at $V_b = 2$ V, T = 40 K, and $\lambda_p = 10$ μm. The measured full-width half maximum (FWHM) spectral bandwidth was measured at $\Delta\lambda/\lambda_p = 40$ % and the detectivity was calculated as $D^* = 1.1 \times 10^{10}$ cm-Hz$^{1/2}$/W. Two distinct response peaks were found for the MWIR QWIP at 4.8 and 5.4 μm with maximum responsivities of 12 and 19 mA/W (at T = 77 K and $V_b = 5$ V), and FWHM spectral bandwidths of 21% and 26%, respectively. The detectivity for the MWIR stack at $\lambda_p = 5.4$ μm, $V_b = 1.0$ V, and T = 77 K was found to be $D^* = 5.5 \times 10^{11}$ cm-Hz$^{1/2}$/W. In addition, a novel PCSL QWIP structure was designed for use as a broad band LWIR detector. This new device also uses the InGaAs/AlGaAs/GaAs III-V material system to form an intersubband detector capable of having a relatively flat responsivity throughout the complete LWIR (8-14 μm) band. More innovative and novel device ideas for QWIPs will be discussed in this report, along with a brief summary of other experimental work performed during this research program.

Connectionist Learning Methods for Reinforcement Learning Tasks: *Does Second-Order Information Help?*

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Abstract

Artificial neural networks (ANNs) have been shown to be useful function approximators. Reinforcement learning (RL) has used ANNs to approximate Q-functions. value functions. etc. While these methods have shown promise, their slow convergence to an optimal policy is frustrating and is an obstacle for their use in RL. This study looks at RL from a connectionist learning point of view and assesses several ANN learning methods. Specifically, backpropagation, backpropagation with momentum, conjugate gradient, and quasi-Newton (one-step secant) learning methods are compared on a simple RL task. The author hopes to provide insight into the behavior of both. first- and second-order methods in an RL setting.

Keywords: reinforcement learning, conjugate gradient, second-order methods, machine learning, neural networks, backpropagation, gradient descent, Quasi-Newton methods.

THE N=2 ANALYTIC SOLUTION FOR THE EXTENDED NONLINEAR SCHRODINGER EQUATION

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Abstract

The extended nonlinear Schrodinger equation (ENLS) and nonlinear optics was studied. To obtain the analytical solution for the ENLS, an understanding of the inverse scattering method was required; as well as a working knowledge of soliton behavior. The analytical solution for the N=2 case for the extended nonlinear Schrodinger equation (ENLS) was derived. The ENLS takes into account the higher order dispersion terms and an analytic solution will aid in particular those researching nonlinear fiber optics.

A LABORATORY STUDY OF PLASMA WAVES PRODUCED BY AN X-MODE PUMP WAVE

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ABSTRACT

An exploratory study of plasma waves produced by an extraordinary-mode pump wave was performed in the laboratory device known as the Versatile Toroidal Facility. Spectral measurements performed *in situ* indicated that resonant modes of the vacuum chamber were obscuring any interesting plasma phenomena that might have been occurring. Modifications that would allow launching of an arbitrary polarization pump wave were conceived. Once implemented, these changes would allow laboratory modeling of a wide range of ionospheric plasmas, including auroral, mid-latitude, and equatorial plasmas. Also, an angularly-scannable probe was designed that would allow extraction of some information about the direction of $\vec{k}$ in future VTF studies.

PRELIMINARY SPECIFICATIONS FOR SCREEN AND ANIMATIONS FOR INSTRUCTIONAL SIMULATION SOFTWARE DEMO

Jennifer L. Day

Abstract

The documents contained in this report are preliminary specifications in an effort to develop a proof of concept demo which will serve to demonstrate the capabilities and benefits of a desktop instructional simulation for Basic Fighter Maneuver (BFM) training. With issues of cost and safety as well as the call for more effective and efficient training, there is an increasing demand for more ground-based training and practice (Mattoon, 1995).

A discussion of the many benefits of desktop instructional simulation to pilot training are beyond the scope of this report. However, a few key benefits are mentioned here. In contrast to traditional hand gestures and planes on sticks to illustrate maneuvers, the use of three-dimensional animation, audio and simulation can provide students with the visual-specific information and situational contexts for the integration of cognitive and perceptual skills for high performance in dynamic flight environments (Andrews, D.H., Edwards, B.J., Mattoon, J.S., Thurman, R.A., Shinn, D.R., Carroll, L.A., 1995). In addition, the instructional simulation can allow both the student and the instructor pilot (IP) the means to configure individualized supplemental instruction and practice for use in and out of the classroom. This capability can be a factor in helping to reduce the IP's workload. Furthermore, complex flying tasks and concepts can be broken down into subtasks, which can reduce the difficulty students have in understanding and performing the tasks (Andrews, et al., 1996).

The specs for the demo prototype included within this document, focus primarily on the selected objectives of BFM, with an emphasis on Offensive Basic Fighter Maneuvers (OBFM). This work reflects the effort to date. Further development and modification of these and added documents is expected for optimal integration of additional aspects of BFM instruction. Evaluation of the demo will be reported at a later date.

CHARACTERISTIC POLYNOMIAL REQUIREMENTS FOR DYNAMIC STABILITY OF RING WING MISSILE CONFIGURATION

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Abstract

The stability of a ring wing missile configuration is studied. An inverse symbolic analysis based on implied stability is performed. The linearized equations of motion and the Routh-Hurwitz stability criteria are used to develop the characteristic equations for the stick-fixed equations of motion. A numerical sensitivity analysis on the stability derivatives is performed to identify those derivatives which do not significantly contribute to the stability of the roots of the characteristic polynomial.

PROJECTED IMPACT OF A PROTOCOL ADJUSTMENT ON THE INVALID OUTCOME RATE OF THE USAF CYCLE ERGOMETRY ASSESSMENT

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Abstract

Pass, Fail and Invalid outcomes of the US Air Force's Cycle Ergometry Assessment were analyzed from data collected at five AF bases. An Invalid results when the heart rate (HR) response falls outside of the parameters set forth for the assessment (i.e. HR too high or HR below 125 beats per minute (bpm)), the subject requests termination of the assessment, or an error occurs due to either equipment failure or assessment administrator error. Of all tests analyzed 16.4% tests (1548 of 9437) resulted in an Invalid outcome (74.0% Passed, 9.6% Failed). The total Invalid outcomes were then sorted by (seven) categories, and excessive heart rate (HR) i.e., Category 1, accounted for the greatest percentage of Invalids (39.7%). These Invalids are primarily due to the projected workload (WL) being too high. Most subjects who re-test at a lower WL setting receive a score. Therefore, lowering the HR range required for an increase in the WL during the assessment should maintain the HR below the 85% HRmax cutoff and allow for a score to be assessed. Further in depth analysis suggested that a 10-bpm adjustment (decrease) in minutes 3 and 4 of the WL adjustment criteria would potentially reduce the Invalid rate by, at best, only 1.6% of total tests (14.8% total Invalids). This estimate was formulated because most subjects who receive the Category 1 Invalid do not receive any WL progression in minutes 3, 4, or 5. Therefore, no adjustment to the required HR response would affect the WL. The total Invalid rate may be further decreased by other testing protocol adjustments.

A TEST OF THREE MODELS OF THE ROLE OF g AND PRIOR JOB KNOWLEDGE IN THE ACQUISITION OF SUBSEQUENT JOB KNOWLEDGE

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Abstract

Based on data from 83 independent studies with a total sample of 42,399 participants, structural equation models were used to test three theories of the role of ability and prior job knowledge on the acquisition of subsequent job knowledge. Ability and prior job knowledge were measured before entering job training, and subsequent job knowledge was measured at the completion of job training. The three models were: a) a role for ability only, b) a role for prior job knowledge only, and c) a role for both ability and prior job knowledge. Results supported the model with a role for both ability and prior job knowledge. The R^2 for predicting subsequent job knowledge for the model including all jobs was .80. Three other analyses were conducted within job families with very similar results. In all analyses, the causal impact of ability was far greater than the causal impact of prior job knowledge. In the model considering all jobs, the causal impact of ability was about three times that of prior job knowledge.

TIME-TO-CONTACT JUDGMENTS IN THE PRESENCE OF STATIC AND DYNAMIC OBJECTS: A PRELIMINARY REPORT

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Abstract

The accuracy of time-to-contact (*TTC*) judgments in computer-generated visual displays was investigated in conditions that included no, static, or dynamic (moving) non-target stimuli. The number of such stimuli, and their direction and relative speed of movement also were manipulated. Analyses indicated that our tasks yielded traditional *TTC* functions, with undersestimation increasing as actual *TTC* increased (2-, 4-, 8-sec). The direction of non-target stimuli movement influenced *TTC* judgments only when they traveled at the same speed and in the same direction as the target. This effect was most pronounced at the longest *TTC*. Neither the number of non-target stimuli, nor non-target movement in general, affected *TTC* estimates. We suggest that a non-target stimulus may play several roles (have several influences) depending on the task requirements and the display configuration. Ordinarily one would think of non-target stimuli as distractors, but we suggest that when a non-target stimulus moves in the same direction and at the same speed as a target, it can assume the role of a "surrogate target," providing visible cues with which to judge target *TTC*. Within the limits of the conditions of this study, we conclude that *TTC* estimates are very robust, and are not easily influenced by otherwise extraneous variables, including accidental and potentially adverse testing environments. Performance on a *TTC* task, however, also may be determined by the adaptive nature of general strategic cognitive processes. We propose further research to determine if, when, and how extraneous stimuli may influence *TTC* accuracy, and what other adaptive and non-automatic processes might be inloved.

PERCEPTUAL ISSUES IN VIRTUAL ENVIRONMENTS AND OTHER SIMULATED DISPLAYS

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Abstract

Virtual environments are multisensory and highly interactive display systems that come in a myriad of flavors and varieties. These VE systems can serve a multitude of purposes within the scientific, medical, military, industrial, and entertainment fields in ways that more traditional human-computer interfaces simply cannot. Because of all the potential and actual uses for VE systems, developing an optimal VE system is a high priority.

Developing an optimal VE system requires knowing and capitalizing on the capabilities and limitations of human perception, both within a given sensory modality and integrated across sensory modalities. Yet, no available VE system can fully exploit the capabilities of human perception, especially those of human vision. These technological limitations can impose some perceptual tradeoffs in utilizing available VE systems that one must carefully consider.

Conversely, VE systems provide an opportunity to answer some fundamental questions about how humans build up percepts about what is out there and what is going on, both within a given sensory modality (e.g., vision) and integrated across sensory modalities. Although VE systems ideally could mimic real-world experiences, they are not bound by the limitations of the real world (e.g., gravity and the laws of physics). Thus, perception in the simulated world of a VE system can dramatically differ from that in the real world. That is, VE systems allow us to test some limitations and capabilities of human perception in ways that more traditional displays and the real environment do not.

Our challenges this summer were to tackle these issues by thinking and reading, by setting up and conducting some pilot studies to explore the formation of multistable percepts within a virtual environment, and by writing a draft of a review paper based on these ruminations and preliminary results.

A Quantum Mechanical Investigation of the Structure and Properties of Radiation Induced Defects in *a*-SiO_2

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Abstract

The work presented here represents research conducted at the United States Air Force Philips Laboratory concerning the structure and properties of radiation induced defects in the *a*-SiO_2 lattice. Several proposed structural defects are studied and the nonlinear optical properties of one of these defects have been calculated using *ab initio* quantum mechanical methods. In addition, preliminary work directed toward a method for the calculation of the nonlinear optical properties of resonant interactions is presented and some preliminary results are given and discussed. Suggestions for future work aimed at better descriptions of structural defects in *a*-SiO_2 and associated properties are also discussed.

PROJECTED IMPACT OF A PROTOCOL ADJUSTMENT ON THE INVALID OUTCOME RATE OF THE USAF CYCLE ERGOMETRY ASSESSMENT

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Abstract

Pass, Fail and Invalid outcomes of the US Air Force's Cycle Ergometry Assessment were analyzed from data collected at five AF bases. An Invalid results when the heart rate (HR) response falls outside of the parameters set forth for the assessment (i.e. HR too high or HR below 125 beats per minute (bpm)), the subject requests termination of the assessment, or an error occurs due to either equipment failure or assessment administrator error. Of all tests analyzed 16.4% tests (1548 of 9437) resulted in an Invalid outcome (74.0% Passed, 9.6% Failed). The total Invalid outcomes were then sorted by (seven) categories, and excessive heart rate (HR) i.e., Category 1, accounted for the greatest percentage of Invalids (39.7%). These Invalids are primarily due to the projected workload (WL) being too high. Most subjects who re-test at a lower WL setting receive a score. Therefore, lowering the HR range required for an increase in the WL during the assessment should maintain the HR below the 85% HRmax cutoff and allow for a score to be assessed. Further in depth analysis suggested that a 10-bpm adjustment (decrease) in minutes 3 and 4 of the WL adjustment criteria would potentially reduce the Invalid rate by, at best, only 1.6% of total tests (14.8% total Invalids). This estimate was formulated because most subjects who receive the Category 1 Invalid do not receive any WL progression in minutes 3, 4, or 5. Therefore, no adjustment to the required HR response would affect the WL. The total Invalid rate may be further decreased by other testing protocol adjustments.

AIR FORCE OFFICER QUALIFYING TEST (AFOQT): FORMS Q PRELIMINARY AND OPERATIONAL EQUATING

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Abstract

This report is an edited version of the technical report written during the Air Force Office of Scientific Research (AFOSR) Summer Research Program documenting the construction of the AFOQT Forms Q1 and Q2 and the subsequent preliminary and operational equating of these forms to the previous AFOQT Forms P. The full technical report contains three main sections; the first section discusses item selection and the procedures involved in constructing Forms Q, the second section covers the item, subtest and composite level statistics and equating statistics, of the 1993 data collection used for the preliminary equating analyses, and the third section provides this information for the 1995 data used in the operational equating analyses. These equating analyses are integral in linking the new forms of the AFOQT to previous forms to ensure equivalence of measurement and thus, these two sections on the preliminary and operational equating have been retained for discussion in this abbreviated version of the technical report. Results suggest that Forms Q1 and Q2 are sufficiently parallel to one another and equivalent to previous Forms P. Preliminary and operational equating analyses suggest that the cubic smoothing equipercentile equatings are the optimal equatings for each of the five composites on each test form. Using this equipercentile equating with cubic smoothing, preliminary and operational conversion tables were developed and are presented in the full technical report. Readers seeking more extensive coverage of this topic and the discussion of the Forms Q test development effort should consult the full technical report which is currently under review by personnel at Armstrong Laboratory.

RESEARCH AND DEVELOPMENT OF A HIGH SPEED HIGH VOLTAGE SEMICONDUCTOR SWITCH

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Department of Electrical Engineering
Auburn University

Abstract

Research was done on the development of a high speed, high voltage, Field Effect Transistor (FET). A preliminary fabrication process was developed for the switch which was then modified to meet unique fabrication problems. After testing the switch, further modifications were made to the process. As of this writing, the switch is still in the terminal stages of development and fabrication.

Investigation of Photoluminescence Intensity
Saturation and Decay, and Nonlinear Optical Devices
in Semiconductor Structures

Jeremy A. Grata

Abstract

We have observed saturation of photoluminescence peak at low pump intensities in growth-interrupted asymmetric-coupled quantum-well structure. We believe the saturation is due to filling of the exciton states localized at the interface islands. We have observed increase of the photoluminescence decay time as pump intensity increases in the same structure.

Based on our design, a new multilayer structure was grown for demonstrating transversely-pumped counter-propagating optical parametric oscillation and amplification, and achieving surface-emitting sum-frequency generation in a vertical cavity.

We have attempted to mode-lock Ti:Sapphire laser pumped by an Argon laser. We conclude that stability of the Argon laser is crucial for achieving stable mode-locking.

ATMOSPHERIC ATTENUATION MODELING FOR LPI COMMUNICATION PERFORMANCE ANALYSIS

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Abstract

The Low Probability of Intercept Signal Detectability Analysis (LPISDA) computer simulation model is used to determine the vulnerability of communication systems to interception. Currently LPISDA includes only free-space path loss in it's link loss computations. In order for LPISDA to become a useful tool for determining signal vulnerability in all types of weather conditions, it is necessary to find an appropriate weather attenuation model to interface with LPISDA. The goal of this project is to locate the best model to use and integrate into LPISDA.

A WEB BROWSER DATABASE INTERFACE USING HTML AND CGI PROGRAMMING

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Abstract

As more machines are able to access data on the Internet, access to data through this medium will become more important. Among the reasons for this approach are platform-independence, ease of use, and minimal client requirements. In this paper, a project implementing a Web-based Interface to an image database will be discussed.

A STUDY OF THE GRAIN BOUNDARY BEHAVIOR OF NANOCRYSTALLINE CERAMICS

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Abstract

The grain boundary behavior of nanocrystalline ceramics was investigated. To reduce ceramic powder to nanosize, a Union Process HD-01 attritor was used. Research indicates that several controllable factors affect grain growth: initial particle size, sintering temperature and pressure, method of compaction, additives, and degree of contamination/homogeneity. By controlling these factors one can produce materials with superior physical and mechanical properties to those of conventional powders/powder processing techniques.

USE OF THE UNIVERSAL GENECOMB ASSAY TO DETECT *ESCHERICHIA COLI* 0157:H7

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ABSTRACT

The Universal *GeneComb*™ test kit from BioRad is based on DNA hybridization and is used for the rapid detection of PCR-amplified biotin-labeled DNA. Using very specific probe sequences, this kit may be used to detect the 60 megadalton (MDa) plasmid and the Shiga-like toxins (SLTs) of *Escherichia coli* O157:H7. This method proved to be simple and effective. It allowed for a rapid analysis of the PCR-amplified DNA.

Error Propagation in Decomposition
of Mueller Matrices

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Abstract

A decomposition for Mueller matrices into three physically descriptive components was recently developed by Shih-Yau Lu [Lu, 1995, Lu and Chipman, 1996]. The effect of experimental error on this decomposition was studied. Both analytical and numerical methods were employed. Symbolic expression of the component matrices in terms of the original Mueller matrix elements shows how errors in the original matrix propogate through the decomposition. Complete symbolic decomposition was given for nondepolarizing Mueller matrices and their associated physical parameters; however, the depolarizing case produced unmanageably large expressions, so approximations were used. For the numerical results, Mathcad™ was used to randomly generate Mueller matrices, incorporate errors, and to analyze the effect of these errors on the decomposition. Results indicate that the error within the component matrices is proportional to the original error within the measured Mueller matrix, and that the proportional constant increases with each subsequent step in the decomposition. In addition, Cloude's method for eliminating "noise" in a Mueller matrix was employed, and its effect on error distribution was analyzed [Cloude, 1986, Cloude, 1989].

EFFECT OF DISSOLVED ORGANIC MATTER ON Fe(II) TRANSPORT IN GROUNDWATER

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Abstract

As the focus of groundwater remediation efforts shifts increasingly towards natural attenuation as an alternative method for subsurface restoration, a great deal of research must now focus on methods for documenting and quantifying such intrinsic remediation. One indicator of natural attenuation under iron-reducing conditions is concentration of dissolved Fe(II). However, if Fe(II) is to be used to quantify the degradation of groundwater contaminants the processes controlling Fe(II) transport in the subsurface must be better understood.

Dissolved metals, such as Fe(II) can interact with dissolved organic matter (DOM) to produce both mobile and immobile complexes. These complexes may display sorptive characteristics different than those of the dissolved metal alone, thus potentially facilitating or retarding transport of the metal. Microcosm sorption studies were conducted to determine the effects of DOM on Fe(II) sorption to aquifer solids from 3 U.S. Air Force Bases as a function of ionic strength (I). DOM at a concentration of 32 mg TOC/L resulted in a marked increase in the sorption of Fe(II) to each of the aquifer solids at $I = 0.01$ M, as judged by Freundlich non-linear isotherm fits of the data. Sorption of Fe(II) in the presence of DOM at $I = 0.1$ also increased over that of DOM-free systems but was less than that in the $I = 0.01$ systems, indicating a inverse relationship between Fe(II) sorption and ionic strength.

Validity of ASVAB Selector AI and FSG for ASVAB Paper and Pencil Forms 15, 16, and 17 and CAT Forms 1 and 2

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Abstract

Validity of the Armed Services Vocational Aptitude Battery (ASVAB) forms 15, 16, 17 and Computer Adaptive Test (CAT) forms 1 and 2 was investigated. The Air Force constructs four vocational classification composites from the ten subtests within the ASVAB. They include Mechanical (M), Administrative (A), General (G), and Electronic (E). A proposed replacement for the A composite, A1, was also computed and investigated. Composite scores and final school grades (FSG) were compared for 44,929 non-prior enlisted military personnel in 110 technical schools using a two-tailed Pearson Product-Moment correlation. Average validities across classification composites, as well as validities for technical schools within each composite, were computed. Correlations were then corrected for range restriction.

All five of the composites showed significant average correlations with final school grades. Electronic composite scores had the highest average validity at .44 uncorrected, .70 corrected. This was followed by General at .34 (.47 corrected), Proposed A1 at .30 (.36 corrected), Mechanical at .28 (.46 corrected) and Administrative at .07 (.28 corrected). Of the 110 schools assessed, 6 had nonsignificant correlations between final school grades and ASVAB composite score. However, by using the Proposed A1 composite in place of the Administrative composite, that number was reduced to 4 and included a dramatic increase in predictive validity in assessing Administrative schools.

RAMAN IMAGING AS A TRANSCRITICAL COMBUSTION DIAGNOSTIC

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Abstract

Transcritical liquid injection plays a fundamental role in rocket combustion for the majority of our current (SSME) and future high pressure rocket engines. However, the fundamental physics behind supercritical combustion are barely understood.[1] One reason for this is the difficulty in making quantitative or even qualitative measurements under these conditions. The objective of this research was to develop experimental techniques to provide crucial data for better understanding transcritical phenomena and semi-empirical correlations for use in predictive computational codes. For this experiment, Raman scattering was used to provide a signal based on species concentration in a transcritical environment. Calibration was performed for both the transcritical pressure vessel instrumentation and of the Raman scatter imaging instrumentation. Unfortunately, due to technical difficulties, no actual two phase flow data was taken.

ON THE DESIGN OF Nd:YAG, Nd:YVO_4 and CrTmHo:YAG LASERS

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Abstract

The Nd:YAG and Nd:YVO_4 lasers were operated at a wavelength of 1 micrometer. Different output couplers were compared and acousto-optic Q-switching was performed. Power measurements for cw operation were made. For the Q-switched experiments, a silicon photodetector was used to detect the pulses. In all of the preceding experiments, a Titanium Sapphire laser was used as a pump source. The CrTmHo:YAG was cooled to 77K and operated at 2.1 micrometers. It was pumped with a modulated diode laser and the output pulses were detected via a liquid nitrogen cooled InSb photodetector.

THE SYSTEMATIC EVALUATION OF ARTERIAL BLOOD PRESSURE REGULATION THROUGH THE ASSESSMENT OF BARORECEPTOR SENSITIVITY AND RESPONSIVENESS TO LOWER BODY NEGATIVE PRESSURE, CAROTID NECK SUCTION, AND INTRAVENOUS INFUSION OF ADRENERGIC AGENTS

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Abstract

High blood pressure (hypertension) is a condition affecting more than 50 million Americans. Only 10% of the cases are the result of a known etiology. The remaining cases are classified as essential hypertension, meaning that the cause of the condition can not be identified. Prior to the development of successful interventions for hypertension, it is essential that we understand the mechanisms responsible for the regulation of arterial blood pressure.

Blood pressure regulation is a function of the autonomic nervous system (ANS). The integrated baroreflexes (cardiopulmonary, carotid - cardiac, and aortic) play a major regulatory role during orthostatic challenge. The development of experimental protocols which systematically separate these regulatory centers and evaluate their efficacy as isolated entities is essential to furthering our understanding in this area.

The cardiopulmonary baroreflex increases vascular resistance in response to reductions in central venous pressure (CVP), resulting in the maintenance of systemic blood pressure during orthostatic challenge. An LBNP protocol is used to reduced central venous volume thereby causing a reduction of CVP. Reflex sensitivity and responsiveness are evaluated through changes in forearm vascular resistance resulting from the reduction of CVP. The carotid - cardiac baroreflex reduces heart rate thereby maintaining systemic pressure in response to increases in carotid distending pressure. A specialized neck chamber device covers the anterior two thirds of the neck and provides negative pressure to the carotid - cardiac baroreceptors.

AN AM1 STUDY OF BIPOLARONS IN DISCRETE CONJUGATED MOLECULES WITH PENDENT ELECTRON WITHDRAWING GROUPS

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Abstract

Molecular modeling, using several programs, was used to predict the electronic properties of conductive polymers starting with discrete monomers, dimers and trimers and extrapolating to higher molecular weights. GAMESS, HyperChem, and GAUSSIAN92 were used to implement semiemperical AM1 calculations, and the results of the various programs were compared. The band gaps, torsion angles, and inter–ring bond lengths were calculated within GAMESS, and neutral and dicationic species were compared. The band gaps were calculated using S_1-S_1 and S_1-T_3 transitions, with the S_1-T_3 calculation yielding results closest to the experimental value of 1.9 eV. The rotational barriers were calculated at the AM1 level within GAUSSIAN92 for the neutral monomers only and are graphed as a function of angle. Using the results of the torsion angle and the inter-ring bond length calculations, the dication extends up to five rings.

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Abstract

Numerical investigation of large arrays of exploding foil initiators (EFI), or slappers, is desirable to minimize the number of design, fabrication and testing iterations during the development process. Simple numerical models of the complete firesystem, including the the non-linear slapper element and the land regions connecting the slappers to the rest of the circuit can be created with basic SPICE elements. This model can then be used to parametrically analyze and optimize designs quickly and with enough accuracy to guide developers. Creating an adequate model is dependent on the development of a accurate model of the land regions for arrays with a large number of EFI's or large land regions.

A STUDY OF WASTE REMOVAL PROCESSES FOR A BARE BASE

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Abstract

There has been a concerted effort throughout the Department of Defense to develop appropriate methods for removing waste generated at a foreign military bare base. A bare base is an Air Force deployment of any number of airmen (this report will focus on 1100 airmen) that can be deployed anywhere in the world with only two requirements: a water source and operating surfaces. The objectives of this report are to create environmentally friendly techniques. similar to those used in the United States, systems that fit within the operational structure of a bare base contingency, and that conform to any international standards for waste treatment. The major focus of the research is to locate data and information that should help in creating the optimal(s) waste collection system.

SUPER-CAPACITOR BOOST CIRCUIT
AND
SUPER-CAPACITOR CHARGER

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Abstract

Large capacitors and their charging circuits have a variety of potential uses in such applications as emergency lighting systems, backup and emergency power supplies, and other applications where battery based systems are not practical. Prior art battery chargers are not suitable candidates for charging these large capacitors because of the high power dissipation and currents encountered at the beginning of the charging cycle.

Our summer research has concluded by our group filing for two separate patents. One patent is based upon a Large Energy-Storage Capacitor Charger. The other patent is based upon a Capacitor-Based Boost Circuit.

Since our group has filed for patents on these circuits, I am prevented from filing a full length report.

SOL-GEL-DERIVED COATINGS FOR SPATIALLY CONTINUOUS PRESSURE MAPPING

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Abstract

The accurate determination of pressure fields over aerodynamic test surfaces is critical to state-of-the-art aerospace development. Computational fluid dynamic (CFD) modeling of unsteady-flow phenomena requires experimental data for development and validation. Surface-measurement schemes using pressure-sensitive and temperature-sensitive paint technology have exhibited potential for the generation of spatially continuous pressure maps of test surfaces. The development of pressure-sensitive coatings has recently been complemented by sol-gel technology. The key advantages of sol-gel-derived composites over conventional paint-binder materials are two-fold. First, sol-gel-derived coatings are characterized by high thermal stability, and are thus good candidates for extreme-temperature applications. Second, novel thin-film architectures have been designed which provide a convenient means to produce thin, uniform films, *and* optimize the sensitivity of these composite coatings for the specific pressure and temperature regimes of interest. Together, these features reflect the potential of sol-gel-derived materials to broaden the applicability of pressure-sensitive paint technology. This approach provides a powerful tool for aerodynamic research that will aid the development and evaluation of CFD models and benefit both the commercial and the military aircraft industries in the United States.

INVESTIGATION OF SYNCHRONIZED MODE-LOCKED FIBER LASERS

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Abstract

A passively mode-locked fiber laser is synchronized to an actively mode-locked fiber ring laser. At injection powers of 1.5 mW stable synchronization is obtained, and several operation regimes are identified.

NON-GAUSSIAN CLUTTER MODELING BY SPHERICALLY INVARIANT RANDOM VECTORS

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ABSTRACT

Conventional radar receivers are based on the assumption of Gaussian distributed clutter. As the resolution capabilities of radar systems improve, the validity of this assumption becomes questionable, and the clutter is often observed to be non-Gaussian. For example, the Weibull and K-distributions have been shown to approximate some experimentally measured non-Gaussian clutter data. In this environment, the detection performance of the Gaussian receiver may be significantly below that of the optimum non-Gaussian receiver. In order to obtain improved detection performance, it is necessary to characterize the correlated, non-Gaussian clutter samples. Spherically invariant random vectors (SIRV's) appear to be an appropriate model for the non-Gaussian clutter. A library of distributions that conform to the SIRV model is presented, as well as efficient techniques for simulating SIRV's. A technique for approximating an SIRV using a multivariate Gaussian-mixture distribution is also proposed.

Keywords: Spherically Invariant Random Vectors. non-Gaussian clutter, Gaussian-mixture

CALCIUM CARBONATE SCALE AMELIORATION USING MAGNETIC WATER TREATMENT DEVICES

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Abstract

The magnetic treatment of water to inhibit scale formation and to remove existing scale deposits continues to engender controversy among water treatment professionals and researchers. However, if magnetic water treatment for scale inhibition were proven, even in limited applications, there would be significant economic and environmental benefits to its use in industry. Even if magnetic treatment for scale amelioration is successfully demonstrated, enough must be understood of its causative mechanisms or its window of applicability so that it may be successfully incorporated into operating industrial systems.

This summer research final report summarizes efforts to find answers to some of the many questions still existing on the topic of magnetic water treatment for scale amelioration. The report begins with an extensive literature review to focus on some of the proposed mechanisms; the problem areas; the best parameters to measure; and methodologies to measure potential changes in calcium carbonate crystals. This review of historical US work, international research, and examples of both successful and unsuccessful applications provides a context for understanding the controversy. Explanations are proposed for the wide diversity of results experienced in both laboratory studies and field trials. An introduction to the large number of variables that affect magnetic water treatment is briefly discussed. A summary of the proposed mechanisms of how magnetic treatment affects scale formation is listed. Recommendations for testing magnetic devices are distilled from successful tests.

The remainder of the report summarizes the system design requirements, planned examination techniques, test plan and design of a test system for examining some of the questions derived from the literature review. This test system will be built and used for parameter testing in the immediate future.

USAFA TRISONIC WIND TUNNEL ANALYSIS FOR HEAT TRANSFER MEASUREMENTS

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Abstract

The United States Air Force Academy wishes to develop the capability to conduct heat transfer measurements as part of its high speed research program. This capability will enhance the educational aspects of its cadet technical training as well as support on-going research conducted in support of defense research programs. The study presented in this paper analyzed requirements for the application and implementation of heat transfer measurement techniques in the Academy's Trisonic Wind Tunnel facility. Specifically, experiments were conducted in the tunnel and assessed operational issues associated with the application of heat transfer measurements to the tunnel.

This study found that a model placed in the low enthalpy tunnel in its current configuration undergoes a relatively small temperature change. Moreover, this narrow temperature range has significant impact on the accuracy of the measurements. This problem is aggravated by unsteadiness in the total temperature of the flow. Potential solutions to this problem are implementing active control of the flow total temperature; changing of model materials from Stycast those with lower thermal conductivities, such as Plexiglas or RTV rubber; or selecting measurement techniques with higher accuracies. The recommended next phase to this development process is to conduct preliminary tests using thermal mapping in a selected temperature range.

A COMPARATIVE STUDY OF NUMERICAL SCHEMES AND TURBULENCE MODELS IN PREDICTING TRANSVERSE JET INTERACTIONS WITH A SUPERSONIC STREAM

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Abstract

A numerical simulation investigation was conducted to study the flow field near a normally injected secondary flow into a turbulent, supersonic freestream over a flat plate. Different numerical schemes and turbulence models were assessed in terms of their ability to predict the resulting flow field with its complex shear layers, multiple shocks and subsonic recirculation regions. Two implicit Navier-Stokes solvers, namely, COBALT and NPARC, and four turbulence models, were used in the numerical simulation. The computational results are presented and compared with existing experimental data for the separation point and surface pressure distribution. The results indicate that the best agreement with the experimental data in terms of separation point location were obtained with COBALT using the one equation Spalart-Allmaras turbulence model, while the closest agreement with the separation induced pressure rise upstream of the slot was obtained with NPARC with the two equation k-ω model.

AN OVERVIEW OF THE SCHEDULING PROBLEM

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Abstract

In this paper we present an overview of the scheduling problem and the related constraint satisfaction problem. Because these problems are known to be NP-complete, good heuristics are necessary to efficiently search for solutions. One such heuristic, constraint propagation, involves maintaining the consistency of the domains of uninstantiated variables during the search for solutions. We review three techniques for maintaining consistency of variables while solving binary constraint satisfaction problems. We also consider the issue of benchmarks for scheduling problems and examine in depth a set of benchmarks for linear programming, the Kennington problems, which could be used to test scheduling algorithms.

MEASUREMENT OF THE SOLID FUEL TEMPERATURE DISTRIBUTION AND ABLATED MASS OF A PULSED PLASMA THRUSTER

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Abstract

The Pulsed Plasma Thruster (PPT) is a low average power (less than 200 W) electric propulsion device used for satellite stationkeeping and drag makeup. Most flight qualified thrusters and laboratory PPT's to date consist of a solid Teflon™ (polytetrafluoroethylene, PTFE) bar placed between two parallel planar electrodes in series with a capacitor charged to a few kV. An arc discharge across the face of the fuel block ablates, ionizes, and accelerates a few micrograms of propellant down the electrode rails. State-of-the-art flight qualified PPT's have low thrust efficiency (<10%) along with low specific impulse (1000 s), presumably due in part to a phenomena called "late-time" ablation. The USAF Phillips (Electric Propulsion) Laboratory at Edwards Air Force Base CA, has recently been investigating the sources of these inefficiencies with the XPPT-1 thruster. The purpose of the present research is to investigate power level effects on ablated mass by measuring the temperature distribution within the fuel and average ablated mass-per-shot. This gives an indication of the net deposited energy, and hence, may illucidate the source of propellant inefficiencies. Although the tests are still incomplete, preliminary results indicate that the Teflon fuel bar experiences a temperature rise up to 40 °C for power levels between 2.5 W and 80 W. Also, average ablated mass-per-shot does not seem to increase with increasing power levels, although again, these measurements are scheduled to be repeated in order to improve experimental accuracy.

Complexity, Ontology and the Causal Markov Assumption

Paul B. Losiewicz

ABSTRACT

The question of what constitutes a causal model is significant, as it will lead to a better understanding of the role of causal foundations and heuristics for probabilistic reasoning. It has been argued that in certain cases domain specific considerations can be appealed to in the construction of more efficient causal models that are "non-standard" in the way networks reflect anomalous correlations between nodes. For the most part, the causal assumptions generally invoked [Pearl 1988], [Spirtes, Glymour, Scheines, 1993] do lead to systematic efficiencies based on a reduction in computational requirements for the models they produce. The goal of this paper is to uncover some of the assumptions about causality that undergird current causal models, assumptions which should be kept in mind by those invoking causal relations in the construction of discovery algorithms for causal networks.

PARTICULATE EMISSION ANALYSIS OF A PULSED PLASMA THRUSTER

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Abstract

Propellant inefficiency resulting from the ejection of propellant material in particulate form is characterized in a Pulsed Plasma Thruster (PPT). Exhaust deposits are collected and analyzed using a combination of Scanning Electron Microscope (SEM), Energy Dispersive X-ray Analysis (EDAX), and microscopic imaging. Teflon particulates are observed with sizes ranging from over 100 μm down to less than 1 μm. Estimates of the mass entrained in this form show that the particulates may account for up to 40% of the total propellant mass used. indicating that methods of ameliorating this loss mechanism would result in significant improvements in the PPT thrust efficiency.

EFFECT OF HEAT TREATMENT ON CYCLIC BEHAVIOR OF Ti-22Al-23Nb

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Abstract

This research is part of a study in which the main objective is to get a comprehensive understanding of the dependence of fatigue properties on microstructure for the orthorhombic-based titanium aluminide alloy Ti-22Al-23Nb (at.%). Cyclic properties such as the total fatigue life (up to 10^7 cycles), nucleation life, microcrack propagation and macrocrack growth life, will be determined at 23°C and 540°C. In addition, the effect of environment is to be established by performing tests under both air and vacuum conditions at elevated temperature.

In this initial state of the project, the material has been characterized by determining the beta transus temperature and by selecting the heat treatment parameters for two desired microstructures. These microstructures differ mainly in the content of the ordered phases (α_2, beta, and orthorhombic) present. Thus far tensile testing at both temperatures and fatigue testing at room temperature, the latter to establish an SN-curve, has been accomplished for only one of the microstructures. Fractographic analysis has been used to correlate test results with the corresponding microstructural features.

THE EFFECT OF BOTTOMSIDE SINUSOIDAL IRREGULARITIES ON A TRANSIONOSPHERIC SIGNAL

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ABSTRACT

The scintillation of a transionospheric signal is caused by scattering imposed on the signal in the ionosphere combined with diffraction effect after the signal exits the ionosphere, and the horizontal displacement of this perturbation caused by ionospheric drift. A quasi-particle approach is used to study the phenomenon caused by the bottomside sinusoidal (BSS) irregularities appearing in the equatorial F region of the ionosphere. A three second sample of high-resolution density perturbation data obtained in situ by the low orbiting Atmosphere-E (AE-E) Satellite (orbit 22700, 12/11/79) during its passage through BSS irregularities is modeled by the superposition of three basic functions. The parameters used in the density model of the irregularities capture the realistic spectral information for the present study. Numerical results are presented, and their physical significance discussed.

A QUANTITATIVE REVIEW OF THE APTITUDE TREATMENT INTERACTION LITERATURE

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Abstract

Aptitude treatment interactions (ATI) describe the idea that the optimal learning environment for any given person depends on their unique set of aptitudes (Cronbach & Snow, 1981). This study integrates the ATI literture by developing a framework for aptitude treatment interactions and quantitatively reviewing the relevant literature within this framework. Studies were coded based on student level, study design, how the dependent variables were measured, what type of aptitudes were investigated, how aptitudes were measured, the type of instruction manipulated, instructional method, and course content. Frequencies were then calculated for each category. Results indicate that researchers typically examine cognitive aptitudes, conative aptitudes, and affective aptitudes. In addition, comparing a structured to unstructured approach and an elaborative approach to one that provides little additional information were the most common ways to manipulate the treatment. Finally, the review suggests that traditional instructional methods such as, lecture, discussion, practice, and textbook use are still among the most frequently used methods for instruction. Implications from this study will be used to develop a taxonomy for classifying individual characteristic variables for training.

CHARACTERIZATION OF SEMICONDUCTOR JUNCTION IGNITOR DEVICE

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Abstract

Semiconductor junction ignitors (SJI) were characterized by analyzing the current and voltage measurements of the devices during excitation by high currents. The resistance, power, specific action and energy of the device as a function of time were determined. Calculations were made to determine the theoretical burst time of the device, which aided in determining the actual burst time. These are the preliminary characterizations of the SJI device that will be followed up by a more detailed study in the near future.

Assessment of the Reliability of Ground-Based Observers for the Detection of Aircraft

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University of South Florida

Jason McCarley

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Abstract

In situations in which ground-based lasers are propagated through the atmosphere, either for entertainment or scientific pursuits, there is the chance that aircrew may be exposed to the beam. In most cases this exposure would not be eye-hazardous, but the effects of flashblindness and veiling glare can nonetheless impair mission performance, with potentially catastrophic consequences. In most situations where such lasers are employed, ground-based observers attempt to identify aircraft that are in or near the beam path; occasionally these observers are aided by FAA radar feeds that can assist them in locating these aircraft. In this study we attempt to determine the effectiveness of observers in the detection of aircraft under a variety of conditions, including day versus night, and with and without the assistance of a radar feed. Preliminary data collected at Sandia National Labs in Albuquerque, NM, suggest several points. First, detection range is very much greater at night than in the day, probably due to the high contrast between the aircraft and night sky from aircraft lighting, and the increased visual sensitivity of the observers in scotopic viewing. Second, the assistance of a radar feed for daytime observation is important in aircraft detection, not so much to increase the range at which the aircraft is visually acquired, but to increase the likelihood that the aircraft will be detected at all. In further analysis of the complete data set we will examine the impact of various ground and sky conditions that can mitigate the performance of the observers.

A STUDY OF A THREE LEVEL MULTIPLE QUANTUM WELL LASER

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Abstract

The design of a three level Si/ZnS multiple quantum well is examined. The structure consists of three alternating layers of a Si well and ZnS barrier. A lasing wavelength in the near infrared, λ=1.55μm was desired. Thus an energy difference between upper and lower lasing levels, (E_3 and E_2 respectively), of 800meV was needed. A MATLAB program was used to examine the properties of various well and barrier sizes in order to achieve this difference in energy levels. Once a structure was found that met this criteria other properties of the laser was calculated, including all energy levels, the dipole matrix elements, the scattering rate due to acoustic phonons and polar optical phonons, and the lifetimes of all energy levels.

COLLISION AVOIDANCE ALGORITHM FOR SPICE

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Abstract

The Space Integrated Controls Experiment (SPICE) requires the utilization of six linear actuators and six magnetic bearings to drive a six-thousand pound mock-up of a space-based-laser in six degrees-of-freedom. The linear actuators, which do not have fixed lines-of-action, are often required to move through large angles of rotations. Possible contact points between the linear actuators and the test article were studied and an algorithm was developed to determine the minimum distance between each linear actuator and the test article. The algorithm is installed into the computers control software and is designed to terminate operations if the distance between the linear actuators and the test article is too small.

A QUANTITATIVE EVALUATION OF AN INSTRUCTIONAL DESIGN SUPPORT SYSTEM: ASSESSING THE STRUCTURAL KNOWLEDGE AND RESULTING CURRICULA OF EXPERT AND NOVICE INSTRUCTIONAL DESIGNERS

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Abstract

The Guided Approach to Instructional Design Advising (GAIDA) is an automated instructional design (ID) tool developed at Armstrong Laboratory's Technical Training Research Division. Based on Gagné's nine events of instruction, GAIDA was developed to aid content domain experts, who are novices in instructional design, in the planning, development, and implementation of quality computer-based instruction (CBI). A systematic, quantitative evaluation is being conducted to determine whether GAIDA can be used to acquire the skills that would otherwise be obtained by means of long-term, on-the-job, instructional design experience. Reaction, learning, and behavioral measures will be collected. Learning will be assessed by administering traditional paper-and-pencil knowledge tests and by investigating the structural knowledge of the participants. A comparison of the knowledge structure of novice instructional designers and expert instructional designers will be conducted before and after the implementation of GAIDA. Several knowledge representation techniques (namely, multidimensional scaling and Pathfinder) will be used to assess the underlying mental models of novice and expert instructional designers to determine (1) the similarity of novice and expert mental models before the implementation of GAIDA, and (2) whether the implementation of GAIDA results in an increase in similarity between the expert and novice mental models of instructional design. Behavior will be assessed by obtaining courseware samples from the participants, which will be rated as to the extent that the courseware incorporates the nine events of instruction proposed by Gagné.

CRACKS AT INTERFACES IN BRITTLE MATRIX COMPOSITES

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and
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Abstract

Interfaces play a key role in the toughness of brittle matrix composites. This study is revealing how friction, toughness, and roughness act in concert to determine the extent of interfacial sliding which may occur near the tip of an impinging matrix crack. The study is bolstered by experiments of cracks at frictional, rough interfaces which reveal the three-dimensional nature of the crack-interface interaction. Critical crack angles are measured at interfaces in dual DCDC specimens.

CONSTANT STRESS INTENISTY DETERMINATION OF FATIGUE CRACK GROWTH RATES THROUGH EXFOLIATION CORROSION IN ALUMINUM ALLOY 7075-T651

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ABSTRACT

Exfoliation corrosion is a potentially severe form of corrosion that frequently affects high-strength aluminum, particularly 2xxx- and 7xxx-series alloys. Exfoliation, which appears as a flaky lifting of the surface, degrades components such as sheets, plates, and extrusions that have highly elongated grain structures.

Although several methods have been developed over the last few decades to evaluate the susceptibility of high-strength aluminum alloys to exfoliation corrosion, few attempts have been made to investigate the effects of this form of corrosion on the fatigue performance of these materials. Therefore, a preliminary study was conducted as part of the 1995 AFOSR Summer Research Program to determine the effects of exfoliation corrosion on the fatigue response of 7075-T651 aluminum alloy plate. The results of that study, which showed potential for increased crack growth rate at lower stress intensities (i.e. below 7 ksi $\sqrt{in.}$), prompted additional work this year to gain increased statistical confidence in the 1995 results.

The experimental program discussed in the result involved testing twenty-four center-crack panels of 7075-T651 aluminum. As in the 1995 program, four different environment/surface conditions were evaluated including: dry air (relative humidity < 15%), humid air (relative humidity >85%), uncorroded, and exfoliated. Both the dry and humid environments were tested in the presence and absence of corrosion damage.

The crack growth experiments were conducted at three constant-ΔK levels per specimen, specifically, 5, 8, and 12 ksi $\sqrt{in.}$, and a summary of the results follows:

There seemed to be no significant crack growth rate increase due to prior corrosion in this alloy and these chemical environments. The data are suspect, as there seemed to be little difference between dry air and wet air crack growth rates. However, higher crack velocities in wet air are well documented by earlier research including our 1995 pilot study. It seems that the dry-air crack growth rates were unexpectedly high, and the reasons for this are not currently understood.

DYNAMICALLY MODELING THE AEDC 16S SUPERSONIC WIND TUNNEL

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Abstract

The 16S supersonic wind tunnel facility at the Arnold Engineering Development Center (AEDC) was modeled dynamically using the one dimensional, time dependent, compressible Euler equations with source terms. The purpose for constructing the 16S model was to determine the source (or sources) of flow unsteadiness observed during some operational conditions in the 16S test section. The approach taken in the development of the 16S model was to modify an existing Euler flow solver that was developed for application to gas turbine engine compressors. Individual models were implemented that represent the 16S components to provide the source term information. These models included wall friction, compressors, screens, heat exchangers, and other pressure loss devices.

STATIC ANTHROPOMETRIC VALIDATION OF DEPTH

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Abstract

The current project examines the validity of the human model in the Design and Evaluation of Personnel, Training and Human Factors (DEPTH) application. A total of 28 anthropometric measurements taken from 17 human volunteers were compared to the measurements taken from the corresponding human model in DEPTH. Although a few dimensions were accurately represented, many had large discrepancies. Some of the measurement deviations could be explained by different measurement procedures, but this cannot account for all of the error. Given the large discrepancy found in the hand and forearm sections of the body, the current version of DEPTH would not allow a designer to accurately simulate reach and grasping tasks. Future research should continue to consider additional anthropometric dimensions which are necessary to realistically simulate a human figure. In addition to static body measurements, it is necessary to examine the human body in motion. To accurately simulate a human performing a task, information about the size, shape and movement of the model are necessary.

PASSIVE MODULATION OF IODINE LASERS AT GIGAHERTZ FREQUENCIES

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Abstract

A photolytic iodine laser is shown to have a 13.59 GHz modulation in the laser radiation when simultaneous lasing of two hyperfine transitions is obtained. The necessary gain tuning required to achieve dual line lasing is accomplished through the use of a magnetic field. In addition, we investigate the possibility of using a nonlinear mirror to increase the gain coupling between the two transitions.

INITIAL SOFTWARE DEVELOPMENT AND PERFORMANCE STUDY OF THE CADDMAS HIGH SPEED, HIGH VOLUME STORAGE BOARD

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Abstract

A high-speed, high-volume TMS320C44-to-PC storage board has been created to support the Computer Assisted Dynamic Data Monitoring and Analysis System (CADDMAS) currently being developed at Arnold Engineering Development Center. Software was written to test the board's features, and a parametric study of the board's performance was conducted to analyze its capabilities and to provide feedback to the board's designers for future revisions. The software is discussed, and a report on the board's performance is given.

EVALUATION OF VARIOUS SOLVENTS FOR THE USE IN A NEW SAMPLING DEVICE FOR THE COLLECTION OF ISOCYANATES DURING SPRAY-PAINTING OPERATIONS

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Abstract

The properties of several solvents were evaluated for their possible use as a collection media, together with derivatizing reagent, for polyisocyanates in a newly developed sponge type air sampler. Several solvent-sponge properties were tested which include sponge expansion after soaked in the solvent, extraction from the sponge by the solvent, loss of any solvent from the sponge during air flow, and polyisocyante recovery from the sponge after sampling. The solvents tested were acetonitrile, toluene, tributylphosphate, butyl benzoate, mesitylene, acetophenone, benzyl ether, benzyl ethyl ether, 2-nitro-m-xylene, and phenetole. Acetonitrile and toluene were very good solvents for preparing polyisocyanate standards, however due to there high volatility could not be used. Acetonitrile was chosen as the solvent of choice for extraction of derivatized polyisocyanate after sampling. Tributylphosphate interfered with the reaction between derivatizing reagent and polyisocyanate and could not be used. Mesitylene, benzyl ether, and benzyl ethyl ether extracted interferants from the sponge thereby rendering each one useless as a working solvent. Butyl benzoate and phenetoleare moderately volatile and could have been considered, however no polyisocyanate recovery from the sponge was detected. Acetophenone and 2-nitr-m-xylene exhibited all of the desirable properties. These two solvents were usable and were chosen for future study as working solvents in the new sponge sampling device.

CORROSION RESISTANT SOL-GEL COATINGS FOR AIRCRAFT ALUMINUM ALLOYS

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Abstract

Sol-gel films were investigated as potential replacements for chromate-based surface treatments on aircraft aluminum alloys. Aluminum alloy 2024-T3 test coupons coated with protective sol-gel films were shown to provide greatly enhanced corrosion protection compared to current protective treatments such as alodyne 1200. Although substantial cracking and pinhole defects were found in most of the films prepared, improvements of up to six orders of magnitude in corrosion resistance were found for selected films. The most promising protection improvement was found in the case of a passivating cerium doped silica subbing layer with an organically-modified silicate (ormosil) overcoat. The sol-gel bilayer was found to give corrosion protection which rivaled or exceeded the complete alodyne/primer/paint topcoat system currently in use by the Air Force.

AN EXPERIMENTAL AND COMPUTATIONAL ANALYSIS OF THE INFLUENCE OF A TRANSONIC COMPRESSOR ROTOR ON UPSTREAM INLET GUIDE VANE WAKE CHARACTERISTICS

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Abstract

Gas turbines are a vital energy source for both industrial and military applications. Recent research has focused on identifying the unsteady flow mechanisms inherent in gas turbines. A progress report is given of a research study utilizing both a computational analysis and experimental tests on the unsteady aerodynamic effect of a downstream transonic compressor rotor on the upstream inlet guide vane/stator wakes. This study should show that the wakes coming off of the upstream stators are significantly affected by the unsteady action of the transonic rotor with its inherent shocks. Currently, design codes do not consider the unsteady aerodynamic effects of the rotor/stator interaction. The purpose of this current study is: (1) experimentally determine if the inlet guide vane surface pressures are changed and gain insight into the driving unsteady aerodynamic processes (2) computationally model the experimental configuration using a nonlinear unsteady multi blade row Navier-Stokes code, identify model weaknesses and make improvements to the unsteady turbomachinery computational code. This report describes the experimental setup and the computational method selected.

INDIVIDUAL DIFFERENCES IN DUAL -TASK PERFORMANCE: EFFECTS OF HANDEDNESS AND FAMILIAL SINISTRALITY ON THE ABILITY TO FLY A SIMULATED AIRPLANE

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Abstract

The influence of familial sinistrality (FS) and degree of subjects' handedness on the ability to perform in a dual-task situation that simulated the control of pitch, roll, and yaw in an airplane's cockpit was examined. While FS and subjects' personal handedness did exert an effect on the dependent measures, the fact that results did not attain significance makes interpretation difficult. Factors limiting the generalizability of the results are discussed, and suggestions for future research proposed. In addition, a tentative explanation for significant ($p < .01$) hand use effects is offered, with the suggestion that greater left hand dual-task interference during the performance of a unimanual spatial task takes place at the level of spatial processing, while greater right hand dual-task interference during performance of a bipedal spatial task takes place at the level of response.

CONSTRUCTION OF KNOWLEDGE BASES DEMONSTRATING IMMUNE SYSTEM INTERACTIONS

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ABSTRACT

Using the qualitative modeling program, The Scholar's Companion (TSC), knowledge bases were designed for general processes of the Immune System. The primary objective was to refine and extend the existing knowledge bases that modeled virus-stimulated cytokine production by immune cells. A qualitiative clock was designed and the four existing virus knowledge bases were developed to be compiled in TSC for envisionment building. When the knowledge bases were complete, envisionment graphics were compared and between experiment differences in process episode progressions were noted. A secondary objective was to develop a novel knowledge base and model for lymphocyte trafficking and cell adhesion molecules involved in the process. Much of this knowledge base was developed in the allotted time, and development will continue as an ongoing project. Both of these objectives are important to and a continuation of the wound healing model currently in development by Robert Trelease.

Detection of Escherichia coli O157:H7 by Multiplex Polymerase Chain Reaction

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Abstract

Escherichia coli O157:H7 is a new enterohemorrhagenic (EHEC) pathogen that has become an important public health issue since it has been implicated in recent food-borne outbreaks due to incompletely cooked ground beef. The ability to identify O157:H7 from other E. coli species and organisms with multiplex PCR conditions would enable a quick and specific diagnosis for this organism. This study tested a number of samples for a 60 MDa plasmid and for Shiga-like toxins (I & II) for PCR conditions. Once established that the test was accurate, multiplex conditions were determined for both plasmid and toxins.

AERODYNAMIC CHARACTERISTICS OF A CONE-CYLINDER-FLARE CONFIGURATION MODEL FROM BALLISTIC RANGE TESTS

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Abstract

Computational fluid dynamics (CFD) has become a valuable tool in the field of aerodynamics. It has been used extensively for systems under steady state conditions, but it is just beginning to be used for unsteady flight conditions. CFD codes must be validated with experimental observations, and the purpose of this work was to perform ballistic range tests which generated data suitable for unsteady CFD code validation. The data from prior ballistic range shots were not ideal for code validation, due to the sparse amount of data per cycle or due to simply a sparse amount of overall data. Three modifications were applied to an existing cone-cylinder-flare model based on predictions using linear analysis: having a quarter, a half, and three-quarters of the flare length removed. From the results, a best design is expected to be with a flare length of one-third of the original length.

ROLLING MOMENT OF INERTIA AND THREE-DIMENSIONAL BOUNDARY LAYER STUDY

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Abstract

A method for experimentally determining rolling moment of inertia for cylindrical bodies is discussed with analysis of experimental uncertainty. The roll-acceleration method was used where a weight was attached to the model and released which caused the model to accelerate in roll. The effect various weight sizes is considered. A description of a three-dimensional boundary layer study is also included. An array of thermocouples was installed on the test article in attempt to detect the presence and wavelength of standing vortices. An array of film probes was used at the maximum energy point in the boundary layer at various locations to measure the wavelength and velocity of cross flow instabilities.

Experimental Study of Rogowski Profile InP and GaAs Wafers

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Abstract

This report explores several different processes using Rogowski profile InP and GaAs wafers. There should be no noticeable difference in the photoluminescent (PL) spectrums of the bare wafers from the standard, but with the addition of the passivation layers on these samples, small differences are expected. The PL experiments should give valuable information on the carrier concentration of the intrinsic InP wafer, as well as the passivated ones. With the photoconductive antenna measurements, the results should be comparable to data of typical photoconductive antennas, with an extension to bias voltages exceeding 10 kV. The results of the PL measurements, and their effects on the wafers' success as photoconductive antennas will be discussed, with suggestions for future investigations.

THE EFFECT OF SHORT DURATION RESPIRATORY MUSCULATURE TRAINING ON TACTICAL AIR COMBAT MANEUVER ENDURANCE AND RECOVERY

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Abstract

The purpose of this study is to test the effect of a low frequency, short duration respiratory musculature training (RMT) program on tactical air combat maneuver (TACM) endurance in experienced acceleration research subjects. Also of interest is the effect of RMT on recovery from the TACM. While studies such as these have been conducted examining general strength training of the skeletal musculature, only minimal acceleration research has been conducted utilizing specific training of the respiratory musculature, despite the critical role the respiratory musculature plays in the intra-thoracic pressure component of the anti-G straining maneuver. Subjects will be randomly assigned to either the respiratory musculature training group (RMT) or the control group. Variables [units] to be measured include: peak heart rate response to TACM [beats$\cdot$min^{-1}], TACM endurance [s], subject perceived effort (ordinal scale) during TACM, subject recovery time from TACM [s difference between TACM replications], aerobic capacity (VO_2 peak) [ml$\cdot$kg$^{-1}\cdot$min^{-1}], peak and mean anaerobic power [W], miscellaneous body composition variables (fat mass, fat-free mass, etc.), maximal inspiratory/expiratory pressures [mm Hg], maximal inspiratory/expiratory capacities [ml], maximal inspiratory/expiratory flow rates [ml$\cdot$s^{-1}]. My role during the 10-week tour was to revise the original proposal for review board approval and to organize the laboratory so that they may initiate data collection on this project.

IN VITRO EVALUATION OF LUMPED PARAMETER ARTERIAL MODELS OF THE CARDIOVASCULAR SYSTEM

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Abstract

Five electrical analog models of the arterial system were tested for accuracy in predicting systemic arterial compliance (SAC) and total peripheral resistance (TPR). Aortic pressure and flow waveforms were generated using a cardiovascular dynamics simulation modeling (CDSM) system at heart rates and stroke volumes typically seen in rhesus monkeys while the compliance and resistance of the system was simultaneously measured. All five models predicted TPR values 24-29% higher than the measured resistance value due to a non-linear screw clamp resistor used in the experimental setup. The four-element Noordergraaf model produced the most accurate estimates (10% percent error) for SAC, while the inductance and Windkessel models produced errors of 16% and 54%, respectively. The Westkessel and Schroeder models encountered problems due to the high heart rates seen experimentally and reproduced in this study.

MODELING THERMAL DIFFUSION IN PROBLEMS WITH SEVERELY NON-MONOTONIC TRANSPORT PROPERTIES

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Abstract

The modeling of thermal diffusion in problems with non-monotonic thermal conductivity was studied. The chemically reacting thermal conductivity, which exhibited the strong non-monotonic variations was calculated previously (Schmahl, 1996). The data was put into LANL SESAME table form for use with the 2-1/2 Dimensional ALE MHD code called Mach2. Computations were performed to test both the reliability of the unsteady heat transfer problem and to analyze how the code handles the advanced thermal conductivity model. A detailed study of the effects of numerical gridding on the accuracy of the solution was performed. This included modifications to the code for inclusion of the ability to adapt the mesh according to variations in the thermal conductivity. The results indicate that when the advanced conductivity model is used, the accuracy of the solutions is increased.

RESEARCH AND PROJECTS IN CONCURRENT ENGINEERING AND DESIGN FOR THE ENVIRONMENT

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Abstract

As part of a summer internship, a literature survey was performed. The purpose was to identify areas of research in the fields of concurrent engineering and environmentally conscious design that may be of interest to the Air Force. An attempt was made to identify the current state of the art both within and outside of the Air Force structure. Due to time constraints and space limitations, this report certainly is not all inclusive. Based on the information gathered, conclusions have been made, and are presented in the final section of this report.

A longer version of this report was written and attached to a memorandum to Mr. Gerald Shumaker dated September 6, 1996.

JAVA-BASED APPLICATION OF THE MODEL-VIEW-CONTROLLER FRAMEWORK IN DEVELOPING INTERFACES TO INTERACTIVE SIMULATIONS

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Abstract

Interfaces to simulations serve to portray the dynamic behavior of the modeled system. In visual interactive simulations, user interfaces allow an analyst to also interact actively with the executing simulation. Traditionally, the software to display the simulation model and to facilitate user interaction are embedded in the simulation model. Such an integration makes it difficult to maintain large simulation programs and pose limitations in the development of multiple interfaces to a simulation model. This article presents a Java-Based Architecture for Developing Interactive Simulations (JADIS). JADIS applies the Model-View-Controller paradigm to the development of interactive simulations. In JADIS, the simulation model and multiple interfaces to them are separate processes that execute concurrently on distributed machines. JADIS integrates concepts from object-oriented programming, concurrent, distributed processing, and graphical user interface design in developing visual interactive simulations. This article describes the JADIS architecture and presents application of JADIS to the airbase logistics modeling domain.

THE ABILITY TO REPRODUCE PROJECTIVE INVARIANTS OF CONICS

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ABSTRACT

Two experiments were conducted to examine observers' performance on reproducing projective invariants of ellipses. Of interest was whether their performance was stable across time, and also across variations of the presentation of stimuli, such as the observer's viewpoint, the amount of movement of the ellipses, and the presence or absence of a background providing depth cues. Absolute projective invariants for pairs of conics were calculated from the observers' productions. Results indicated that performance varies from subject to subject, and that neither viewpoint, tilt, or background have a significant effect on observers' reproductions.

SYNTHESIS AND CHARACTERIZATION OF NOVEL FLUORINATED VINYL MONOMERS FOR POLYMER DISPERSED LIQUID CRYSTAL SYSTEMS

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Abstract

The synthesis and characterization of several novel fluorinated difunctional vinyl monomers for polymer dispersed liquid crystal systems is presented. The focus of this investigation is the synthesis of monomers which will first replace the cross-linking *N*-vinylpyrrollidone (NVP) in polymer dispersed liquid crystal systems and may ultimately replace the multifunctional penta acrylate matrix monomer.

Materials presented herein are variations on classical liquid crystal architecture featuring a rigid biphenyl backbone with vinyl terminated alkane spacer groups. Synthesis routes included acid chloride and *N,N'*-dicyclohexylcarbodiimide (DCCI) activated esterification reactions. The synthesis of four chain extending monomers is reported, all of which are believed to be novel. A fifth monomer has been isolated from reaction side-products and the purification using low pressure liquid chromatography reported.

ARITHMETIC EFFECTS ON AIMING PERFORMANCE IN COORDINATION: SEQUENTIAL POSITION EFFECTS

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ABSTRACT

Most tasks require coordination of cognitive functioning and perceptual-motor control. For example, an airplane pilot must make high-level decisions about navigation and also reach for and manipulate knobs in the cockpit. The demands of the perceptual-motor tasks can in principle affect achievement of the cognitive tasks, and vice-versa. Remarkably, despite the large amount of research that has been done on isolated perceptual-motor tasks, on isolated cognitive tasks, and on concurrent tasks (tasks that must be performed at the same time), there has been virtually no study of tasks whose defining feature is satisfaction of perceptual-motor goals in the service of cognitive goals. The current study was part of a series of studies that explores how arithmetic processes affect continuous aiming performance when aiming is performed in the service of sequential arithmetic. My goal was to understand a specific pattern of results thought to reflect arithmetic influences on aiming performance, the sequential position effect, characterized by longer aiming times at later steps in an aiming-arithmetic sequence. The results of the study strongly suggest that the sequential position effect reflected active working-memory management processes of arithmetic information, perhaps those involved in evaluating and reconstructing arithmetic calculation results or instantiating a plan for arithmetic calculations to take place.

DOES NITRIC OXIDE MEDIATE CIRCULATORY FAILURE INDUCED BY ENVIRONMENTAL HEATING?

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Abstract

The purpose of this study was to determine whether nitric oxide (NO) contributes to the hypotensive state induced by environmental heating. This was accomplished by competitively inhibiting NO synthesis both before and after environmental heating with a synthetic analog of L-arginine, N^{ω}-nitro-L-arginine methyl ester (L-NAME). Ketamine-anesthetized rats were instrumented for the measurement of arterial blood pressure, ECG, and temperature at five sites. In *Protocol 1*, animals were given L-NAME (10 or 100 mg/kg) or saline i.v., monitored for a period of 10 minutes, and then heated at an ambient temperature of $40 \pm 1°$ C until MAP decreased to 75 mmHg. Heating was then stopped, and the rat was monitored until death. In *Protocol 2*, animals were heated at an ambient temperature of $40 \pm 1°$ C until MAP decreased to 75 mmHg. Heating was then stopped and L-NAME (10 or 100 mg/kg) or saline was immediately administered i.v. There was no difference in survival times between L-NAME and saline-treated rats in either protocol. These results indicate that bolus administration of L-NAME does not reverse hypotension induced by environmental heating, suggesting that excess levels of NO do not mediate this form of circulatory failure.

THE SIMULATION OF PREFERRED ORIENTATION DEVELOPMENT USING popLA/LApp° DURING UNIAXIAL COMPRESSION

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Abstract

It is well known that crystal anisotropy (texture) develops in any material when experiencing plastic deformation. Therefore eliminating anisotropy is not usually possible and neglecting its effects can cause significant non-reproducibilities. In some cases, the anisotropy may actually be taken advantage of to yield properties whose directionality may be matched to the need at hand. Therefore controlling and predicting these non-uniformities is important and allows one to design processes which at least account for the inconsistencies. X-ray diffraction pole figures may be used to calculate harmonic equation coefficients from which the orientation distribution function (ODF) of a sample may be generated. With the ODF determined, texture dependent (orientation dependent) properties can be approximated with the use of suitable theories and texture development resulting from subsequent plastic deformation may also be modeled. One package of computer codes now available which can manipulate pole figure data to produce the aforementioned results is the Preferred Orientation Package-Los Alamos (popLA©) and Los-Alamos Polycrystal Plasticity code (LApp©). The goal of this research was to explore the current possibilities of LApp° with respect to the prediction of texture evolution. The results obtained from the simulations were comparable to experimental data.

Ducted VLF Transmissions and the MIT Broadband VLF Receivers

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Abstract

The propagation of whistler-mode signals from ground-based VLF sources in ionospheric ducts is discussed as it pertains to planned experiments at the Arecibo Observatory in September 1993. An experiment to study the effects of HF heating on naturally occurring ducts and conjugate propagation effects is defined, and the design of broadband VLF receivers and antennae for use in the experiment is detailed.

Balloon Launch Retromodulator Experiment

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ABSTRACT

Under the AFOSR summer research program researchers from Utah State University / Space Dynamics Lab spent 12 weeks at the Phillips lab preparing and flying a retromodulator laser communication package on a high altitude balloon. The package was a prototype system for a low-power laser communications system for small low earth orbiting satellites. The work was divided into preparation of the ground station at Starfire Optical Range, assembly and testing of the retromodulator control electronics, micro controller programming and the actual balloon flight of September 15, 1996. All technical objectives of the experiment were met during the 1 1/2 hour flight of the balloon which reached a float altitude of 103,000 ft. The ferroelectric liquid crystal based retromodulator design of Utah State provided test patterns for modulation rates up to 20 kilo bits. Data was successfully down linked using a 1200 bps RS232 format and a simplistic receiver. This report outlines some of the reflected laser communications activities conducted under this summer research program.

DETECTION OF AMPHETAMINE IN URINE FOLLOWING MULTI-DOSE ADMINISTRATION OF FENPROPOREX

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Abstract

The precursors of amphetamine and methamphetamine can be significant in interpreting results of positive amphetamine drug testing. There are a number of drugs that are known to produce amphetamine in the urine of users. Administration of one of these, fenproporex, was reported to be detected for hours, while amphetamine could be detected for days. Administration of fenproporex to five volunteers for a period of seven days resulted in the detection of amphetamine in the urine of all subjects. The concentration of amphetamine reached a steady state for all subjects, with peak concentrations ranging from 2851 to 4150 ng/ml of amphetamine. Peak concentrations were detected 54 to 86 hours after the first dose . Amphetamine was detected (> 5 ng/ml) for up to 177 hours after the last dose. The presence of both enantiomers of amphetamine was revealed in the analysis of the metabolically produced amphetamine. This can be important in establishing whether illicit amphetamine is involved. In addition, the parent fenproporex could be detected in samples where amphetamine was greater than or equal to 500ng/ml.

OPTIMIZATION OF MULTISTAGE MANUFACTURING PROCESS SIMULATIONS
USING GENERALIZED HILL CLIMBING ALGORITHMS

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Abstract

This paper addresses the development of a system which will enable the optimization of an entire manufacturing process sequence. Typically, such a sequence may involve several stages and alternative routes of manufacturing a given part. It is important that such a system be optimized globally (rather than locally, as is the current practice) in order to achieve improvements in affordability, producibility, and performance. This paper features the framework of a generalized hill climbing (GHC) algorithm for searching a very large parameter space, the development of simplified process models, and the explanation of a cost function that evaluates the cost of a particular sequence. Computational results using GHC algorithms for a discrete manufacturing process design problem under study at the Materials Process Design Branch of Wright Laboratory, Wright-Patterson Air Force Base, Dayton, Ohio, USA, are presented.

AN ATM ADAPTATION LAYER PROTOCOL DESIGNED TO TRANSMIT QUALITY-CRITICAL TCP TRAFFIC OVER DEGRADED COMMUNICATION LINKS

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Abstract

When multimedia applications utilize the TCP/IP suite with ATM over high bit-error-rate (BER) links, very poor performance is the result: TCP connections close themselves because of time-outs. These time-outs are the result of TCP's retransmission waiting time mechanism. The retransmission waiting time timer, for a given segment, is doubled each time it times-out, eventually becoming large enough to cause the connection to close itself. Experiments conducted at Rome Laboratory, involving applications that used TCP to transmit data-critical electronic whiteboard and imagery information over a channel with a BER of 4E-6, concluded that TCP connections consistently closed themselves due to time-outs. Since actual tactical links operate with BERs as low as 1E-3, a new tactical AAL capable of working over high BER links needed to be designed. AALx is a proposed solution to this problem. AALx uses the selective repeat ARQ to provide retransmissions to lost or errored frames. The size of the ARQ frame is adaptable to allow maximum performance to be achieved over the wide variety of communication links.

COMPARISON OF Ni/Au AND Pd/Au METALLIZATIONS FOR OHMIC CONTACTS TO p-GaN

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Abstract

The reactions between electron beam evaporated thin films of Ni/Au and Pd/Au on p-GaN (N_A=9.8 x 10^{16} cm^{-3}) were investigated. The depositions consisted of 500 Å Ni or Pd followed by 1000 Å Au. The samples were then heat treated at temperatures as high as 600°C for up to 30 minutes in flowing N_2. Both structural and electrical properties of these contacts were studied in the as-deposited and heat treated states. Auger electron spectroscopy (AES) was used to determine if there was any reaction between the deposited metals and the semiconductor. The electrical properties were investigated using current-voltage (I-V) measurements. The ohmic or rectifying nature of the contacts was determined using room temperature I-V and the dominant conduction mechanism for the Pd/Au scheme was determined by taking I-V measurements over the temperature range of 80-400 K.

THE DEVELOPMENT OF A GENERAL MEASURE OF PERFORMANCE

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Abstract

The U.S. military has invested considerable resources in developing and validating approaches to measuring individual and workgroup performance. However, these approaches have typically been expensive to develop and time consuming to administer. In addition, considerable information about specific job content is often required to develop performance measures using these approaches. This paper describes recent research activities related to the development of a general measure of performance based on recent conceptualizations (e.g., Campbell, 1990a; Borman & Motowidlo, 1993; Viswesvaran, 1993) of the structure of performance which assert that aspects of performance generalize across different jobs. One appealing aspect of such models rests in the ability to develop approaches to measuring and predicting performance which are useful across a broad range of jobs. To date, however, these models have generally been examined at the conceptual level only and have rarely been empirically tested. The present paper describes the development of a core set of items which could be used to (1) empirically test various latent factor models of performance and (2) form the basis for a measure that could be used to obtain general job performance criterion data for a variety of uses (e.g., test validation, program evaluation). Results from the work to date and plans for future activities will be highlighted and discussed.

AIRBORNE BISTATIC CLUTTER MEASUREMENTS:
SYSTEMS ISSUES

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Abstract

This paper reviews airborne bistatic radar scattering programs that have been reported in the open literature. Brief descriptions of the systems considerations of these programs, with respect to hardware, synchronization and calibration issues, and experiment geometry are given. A preliminary design of an airborne bistatic measurement program is given, based on a potential transmitter and receiver. This report summarizes the author's research performed over a 30 day period during the summer of 1996 as a participant in the AFOSR Graduate Student Research Program at Rome Laboratory, Hanscom AFB, MA.

THE ANALYSIS OF AQUEOUS FILM FORMING FOAMS

Christopher G. Walker
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Abstract

Analytical techniques were employed to determine the specific organic components in aqueous film forming foams (AFFF). Electrophoresis was used extensively in an attempt to identify and separate surfactants and non surfactant organic components. In this study we investigated a ion pairing solid phase extraction technique (SPE) to cleanup and separate methylene blue active components. The complexes are then concentrated and derivatized with diazomethane followed by GC/MS analysis. Further laboratory work is needed to definitively characterize the organic constituents in AFFF. The results and limitations of these techniques are discussed.

AUTOMATING THE COGNITIVE TASK ANALYSIS PROCEDURE

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Abstract

Research has shown that students learning from private human tutors learn more efficiently than students learning from a traditional classroom setting (Bloom, 1984). However, private human tutors are not always a viable option. It has been proposed that computer-based tutorials can be used to instruct material as effectively as private human tutors. In an effort to accomplish this, computer-based tutorials must evolve toward intelligent tutoring systems, in which the tutoring system has expertise in the domain being instructed. Subject matter expertise may come from analyzing documents within the domain. However, the primary source of knowledge is obtained through interviews and observations of experts. The time consuming process of eliciting knowledge from experts and organizing the knowledge into comprehensive curricula is referred to as cognitive task analysis (CTA). Shute and Torreano (1995) propose an automated cognitive task analysis procedure designed to elicit comprehensive curricula which encompasses expert knowledge and skills in a more timely manner, compared to existing CTA methodologies. The current paper reviews background literature in the domain of CTA and presents a prototype of an automated CTA procedure.

A STUDY OF COAXIAL VIRCATOR GEOMETRIES

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Abstract

A study of efficiency improvement for a coaxial virtual cathode oscillator is presented. The coaxial geometry has many physical parameters that can be changed to alter the performance of the system. The parameters of interest include the placement of a ring cut in the anode base, and the polarity of the pulsed system. The ring is varied in width and in position from the center line. 43 variations were simulated and results normalized to the original configuration without a notch given. Comparisons of frequency, efficiency and particle dynamics of geometries with the pulsed system positive and negative is given. MAGIC, a 2-$^1/_2$ dimension particle-in-cell code, is used to simulate the different geometries.

EXACT POLE LOCATIONS OF DIELECTRIC GEOMETRICAL OBJECTS IN VARIOUS DIELECTRIC MEDIUM

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Abstract

The problem of buried ordnance detection is introduced. Specific discussion of the buried ordnance problem as it pertains to range cleanup efforts and its' financial future is presented. The dielectric properties of soils and plastic targets are given. The approach for finding exact pole locations from a dielectric infinite slab, a dielectric sphere, and a dielectric infinite cylinder is presented (and applied). The exact poles for the slab and sphere are found for various sizes and dielectric properties. There is a discussion (and use) of Carl E. Baum's perturbation formulas for dielectric slabs and spheres. George Hanson's results (formulas, from using Carl's same approach) are given (and used) for an infinite dielectric cylinder. The poles found from the perturbation formulas are compared with the exact poles and an "effective" region for using the perturbation formulas is established.

A Preliminary Study for Computer Simulations of Plasma-Filled Backward Wave Oscillators

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Texas Tech University

Abstract

In this report, the results of preliminary work for the study of plasma-filled Backward Wave Oscillators (BWO) using the Particle-in-Cell (PIC) code MAGIC is described. After briefly discussing the operating principle of a BWO, the effect of grid heating in MAGIC is illustrated and MAGIC's ability to suppress grid heating is demonstrated. The effects of grid heating suppression on a standard BWO simulations are presented. The primary effect of grid heating suppression on a standard BWO simulation observed is the reduction of the simulated microwave output power. This reduction in output power is mostly likely due to the suppression of space charge waves in the electron beam when grid heating suppression is used. These results suggest that grid heating suppression in MAGIC should not be used in the simulation of plasma-filled BWOs.

INCORPORATING AN HPC PARALLEL TRACKING PROGRAM INTO A DISTRIBUTED, REAL-TIME, TRACKING APPLICATION.

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Abstract

A parallel tracking program, running on an Intel Paragon high-performance computer (HPC) has been incorporated into a real-time, distributed application. The tracking program was merged into the "Multisource Integrated Software Tool" (MIST v2.0) developed by Rome Laboratories. MIST was created to provide an environment in which various target tracking methodologies could be developed and compared. To that end, TCP sockets and XDR streams were added to MIST 2.0 in order to provide robust network communications between differing types of machines in an (inter)networked environment. A group of test program tools was also created to aid in the development of this and future tracking programs to be run on the HPC. Finally, the initial tracking program and final working system were analyzed. This analysis shows that the tracking module efficiently utilized the computing resources available. It also demonstrated that with sufficient computing resources the throughput of the system was limited by network communication rather than in tracking computation. The analysis also showed that, due to the reduction in time spent in the most computationally intensive portion of the tracer, it is now worthwhile to optimize the data association portion of the program.

MEASUREMENT OF 3D REAL-TIME DEFORMATIONS, FORCES, AND MOMENTS OF AIRCRAFT TIRES USING A SYNCHRONIZED OPTICAL AND ANALOG SYSTEM

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Abstract

This report represents some tire mechanical data obtained from measurements using an optical system . It includes the different test-plans of measurements conducted on two different tire test machines. The optical system used is a Charge-Coupled Device (CCD) which can give you a 3D position of the interested points. Vision sensors can be located at a remote distance with passive or active light sources such that the motion of specified points can be detected. The infrared light emitted from the markers is received by the CCD sensor and digitized for real-time display. The optical system is synchronized with additional analog (voltage) channels, which may be connected with load cells, thermocouples and other sensors. An KC-135 and an F-16 tires were used for the mechanical property measurements. Graphics results of some the tests are presented.

OPERATING MAP PREPARATION USING
ARC HEATER CORRELATIONS

Sara Elizabeth Allen
Coffee County Central High School

ABSTRACT

Arc heater correlations are used to predict new operating points for existing arc heaters and to predict how a new scaled up arc heater will operate. Preparations of arc heater operating maps take on the form of Pressure vs. Enthalpy and Voltage vs. Current plots. There are two methods of generating these plots: dimensional and non-dimensional correlations. Although there is only one way to determine the non-dimensional equations, there are five ways to determine the dimensional equations. By graphing all the different dimensional and non-dimensional choices for two different data sets and projecting one up to the other, it was determined that the non-dimensional method is the more accurate for any data set. However, any method works fine for a data set with very little scatter.

The Creation of a Shell Program to Interface to Confor

Jesse Anderson

Abstract

A program was developed in C++ to be used as an interface, file translator, and control mechanism to the Ukrainian developed program Confor, enabling the user to run Confor multiple times using files in a format common in the United States.

CHEMICAL PREPARATIONS OF DRINKING WATER FOR RADIOANANALYSIS

Julio E. Ayala II
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Abstract

Preparation of water samples from bases around the U.S. for radioanalytical purposes was studied. A well mixed, acidified water sample is evaporated, acid-digested, and the residue transferred to 2" planchet. These samples are then counted for gross alpha and gross beta radioactivity. The results indicated that the drinking water samples prepared met the EPA's drinking water standard. However, when the samples do not meet the standards, they are then re-tested or tested for uranium or radium.

A STUDY OF THE GENERALIZATION AND CLASSIFICATION ABILITIES OF A BACKPROPAGATION NEURAL NETWORK

Mark A. Bartsch
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Abstract

The generalization abilities of a backpropagation neural network simulation were examined in three stages. The first stage statistically tested the network's ability to perform 5-bit binary negation under varying network sizes and extents of the training set. It was found that a two layer network was the most accurate, yielding no errors with a training set of sixteen cases. The second stage tested the ability of a network to classify music based on melody. The third stage tested the ability of a network to determine whether or not a point in a matrix was "surrounded" by other matrix elements, based on a partially ambiguous set of rules. Both stage two and stage three were inconclusive because of too few training examples.

COMPRESSOR TESTING

Amy E. Beam

Compressor Research Facility

Beavercreek High School

Abstract

The Compressor Research Facility (CRF) at Wright Patterson Air Force Base, in Ohio, has been testing a compressor for General Electric. Three steps of this testing were done and are written about in the following. A simple and efficient way of adding error bars to data was found. This was important because the accuracy of the data needed to be found quickly. A Pressure Sensitive Paint (PSP) is being developed to replace probes on the rotor blades. The paint is significant in finding the pressure difference inside the compressor. Lastly a new piece was designed for the facility. It is to be placed in the test rig so that the PSP is able to be viewed optically.

APPLICATION OF WORLD WIDE WEB TECHNOLOGIES TO ENHANCE INFORMATION VISUALIZATION

Christina Maimone
Chaminade-Julienne Catholic High School

Mark Beebe
Beavercreek High School

Abstract

The vast growth in capability of World Wide Web technology has brought a new way of communicating and sharing information into many offices. The Logistics Research Division of Armstrong Laboratory is exploring the option of using these technologies in logistics efforts. In order to assist in this endeavor, this project was designed to produce an example of the many capabilities of applying Virtual Reality Modeling Language (VRML) and HyperText Markup Language (HTML) to logistics. In this project, VRML worlds and HTML pages were created and connected to each other. A variety of aspects of the two languages were introduced. As the project developed, some problems were encountered. Among these were response time, file size, and product problems. Some had solutions while others may be fixed at a later time when solutions are discovered. In an effort to relate this project to logistics efforts, some examples were offered for further enhancement including aircraft maintenance manuals and training. Overall, this project was a success and can be used to learn about the many possibilities of using VRML and HTML in logistics.

SYNTHESIS OF A HIGH-ENERGY BINDER

Michael L. Berry
Highland High School

Abstract

Certain ingredients are necessary in order to create an effective propellant. Different methods of preparing solid propellants have been attempted over the years. However, with the high cost of sending material into space, it has become imperative that we develop a cheaper means of making a more cost efficient rocket fuel. What is needed is a propellant ingredient that will create a high-energy propellant at less cost.

The processes and results of experiments attempting to produce a more effective and energetic additive for the liquid oxidizer hydroxylammonium nitrate (HAN) are presented.

A STUDY OF THE EFFECTS OF VARYING CHAIN LENGTH SURFACTANTS ON POLYMER DISPERSED LIQUID CRYSTAL HOLOGRAPHIC GRATINGS

Crystal Bhagat
Dayton Christian High School

Abstract

The focus of this investigation was to study the effect of varying chain length surfactants on polymer dispersed liquid crystal (PDLC) gratings. This included propylpentanoic acid, hexanoic acid, heptanoic acid, lauric acid, and octanoic acid. Also observed was the effect of varying percent weight amounts of the liquid crystal E7 on PDLC gratings. The percents used for this were 30%, 50%, 70%, and 79% E7 weight amounts in the PDLC syrups. PDLC grating samples representing the different E7% syrups and the syrups with the varying surfactants were constructed. They were then characterized by measuring diffraction efficiency and transmission with a helium neon laser at 633nm. Samples representing gratings with the different surfactants were characterized in *s* and *p* polarizations. Switching voltage was also conducted on several samples. Results showed that gratings containing the octanoic or hexanoic acid surfactant will have higher diffraction efficiencies compared to the others. Also, a 30% E7 amount in the PDLC syrup will have better diffraction efficiency, lower transmission, and a higher total light compared to the other percents of E7 experimented. Characterizing at *p* polarization will also give better grating results compared to the *s*.

A Trial of Microencapsulated Phase Change Material of use in modern aircraft as an effective Thermal Barrier

Daniel A. Binkis
Beavercreek High School

Abstract

The objective of the Microencapsulated Phase Change Material (Micro PCM) Advanced Applications effort is to research PCM technologies so that quantitative evaluation of their benefits for innovative aircraft cooling applications can be assessed. This project will evaluate the thermal effectiveness and durability of Micro PCMs embedded in carbon composite structural panels. Micro PCM capsules will be mixed into the resin of composite panels in various concentrations and compared to baseline panels that contain no Micro PCM capsules in the resin. The thermal effectiveness of the panels will be evaluated by applying an external heat flux to the panels and measuring the transient temperature response through the panel. These temperatures will be compared to a one dimensional model of the system. The durability of the panels will be evaluated by thermally cycling the panels in the temperature chamber and observing the results. At the completion of the durability tests, thermal effectiveness tests may be conducted on selected panels to determine if the thermal cycling affected thermal performance. Mechanical property tests including tension and compression will be performed at the conclusion of the thermal cycling tests. The mechanical tests will be conducted by FIB in their facilities. The first phase of this testing will use a carbon composite panel devoid of any Micro PCM capsules in order to attempt to establish several base-line figures for comparison and model design.

CREATING A LONGITUDE AND LATITUDE PLOT USING SAS/GRAPH SOFTWARE

Andrew Binovi
Saint Anthony Catholic High School

Abstract

This report details the methods used to create a graphic plot of certain longitude and latitude points on a United States map. Using the SAS System and SAS/GRAPH software, the approach detailed in this report: isolates the longitude and latitude coordinates in the original source data file, modifies the isolated data to fit the needs of the program, creates an annotate data set, combines the annotated data with a map data set, projects the collection of data and then separates the map and annotated data sets for output. The desired output is a map of the continental United States with an overlaid plot indicating longitude and latitude points.

PREDICTION OF PARATROOP/WAKE VORTEX ENCOUNTERS DURING FORMATION AIRDROP

Matthew L. Blanton

Abstract

A modeling technique is described for predicting the relative locations of paratroops and trailing vortices for a formation of transport aircraft. The wake behind each vehicle is treated as a fully rolled up vortex pair with empirical relations used for the vortex decay. The technique is applied to two and six aircraft formations, with the objective being to maximize the distance between the vortices and paratroops, subject to numerous operational constraints. Nineteen sorties were flown using the formations developed. A total of 286 mannequins and 299 live troops were dropped with no paratroop/wake vortex interactions observed.

USING A SCANNER AND COMPUTER TO UPDATE A TECHNICAL INSTRUCTION MANUAL

Emily R. Blundell
Rosamond High School

Abstract

When using the computer to update the technical instruction manual, many different applications were used (the computer applications that were used were from Windows 95). Using an OP Scanner, the pages were scanned into the computer. Occasionally, the scanner would not allow some pages to be scanned. Then pages that could not be scanned needed to be typed into the computer using a word processing program, such as Microsoft Word. The book included graphs and pictures that needed to be put in the computer also. In doing this the picture or graph was scanned in and then was transferred to an application that could read the pictures, such as Picture Publisher or Image Writer. Once everything is scanned and corrected then it can printed out and put into a binder.

Environmental Aspects in an Industrial Setting

Erica D. Brandon
Coffee County High School

Abstract

During my apprenticeship at Arnold Engineering and Development Center my primary work assignment was in the Test and Facilities Support Department of Sverdrup Technology Incorporated. Working with environmental and manufacturing engineers in the machine and fabrication facility (Model Shop) my duties included studies, analysis and audits of environmental issues that impact this industrial facility. I received various projects, each helping me become familiar with various aspect of the environmental requirements associated with a machine shop.

PREPARATION AND PLACEMENT OF MATERIALS ON THE WORLD-WIDE WEB

Daniel T. Brown
Sauquoit Valley High School

Abstract

The website of the Intelligence and Reconnaissance Directorate, Image Products Division (IRR) was expanded by adding documents and new in-lined images to provide more information to the public and to allow people outside Rome Laboratory to monitor the progress on non-classified projects. This was accomplished through the use of HTML 2.0, Adobe Photoshop 3.0, Microsoft Word 6.0.1, GraphicConverter, SimpleText, and digital pictures handled with a SCSII interface. The HTML documents were written into Microsoft Word and SimpleText documents by adding in the HTML tags and saving as a more accepted Text Only format. The digital pictures were edited and layered using Photoshop to achieve a graphics format that is accepted by GraphicConverter. The next step was to convert the PICT files into a format accepted by a Netscape browser (JPEG format). The documents and graphics were then passed on to the system administrator for placement on the IRR server as to be accessible on the World-Wide Web.

THE STUDY OF A BASIC LDV SYSTEM

Brian E. Brumfield
Tippecanoe High School
&
Matt R. Rabe
Carroll High School

Abstract

The principle setup of an LDV system was researched and setup. LDV is a technique in which particles that are taggers in a fluid flow are illuminated by focused laser beams and become scattered sources of light. This causes a change in frequency (Doppler effect) in the scattered light due to the motion of the particles which the photomultiplier tube will receive and allows the particle velocity to be determined. The minimum requirements for such a system are as follows: A light source such as a laser, transmitting optics, receiving optics, photodetector, signal processor, and a data processor.

THE EFFECT OF PROLONGED GROWTH ON A NON-SELECTIVE MEDIUM ON THE ABILITY OF *PSEUDOMONAS PSEUDOALCALIGENES* JS45 TO GROW ON NITROBENZENE

Jennifer S. Burnett
Bay High School

Abstract

Experimentation was performed to determine if the ability of JS45 to grow on nitrobenzene is stable after prolonged growth on a non-selective medium. JS45 was grown in Mineral Salt's Broth and nitrobenzene, then transferred to a non-selective medium. Dilutions were plated on both non-selective agar and minimal agar with nitrobenzene vapor. This process was repeated several times. Experimental results indicated that the total number of JS45 cells and the number of cells that could grow on nitrobenzene were the same. Concluding that JS45 does not lose the ability to degrade nitrobenzene after prolonged growth on a non-selective medium. Therefore there is no permanent loss of nitrobenzene-degrading ability during non-selective growth, consequently scientists must find another mechanism to explain what causes the prolonged growth lag.

Nicholas G. Butel

Abstract

The process of converting the contents of the Radiofrequency Radiation Dosimetry Handbook into a digital format to be put onto the World Wide Web (WWW) was initiated. This process involved the use of Microsoft Word, Web Author, and Netscape software. The problem of converting mathematical symbols and Greek letters was over come by the use of Adobe PhotoShop to make an image that was placed into the text. In addition to making WWW pages, I worked on creating a mathematical model of a Phantom Monkey. This process involved using axial magnetic resonance imaging scans of the phantom. The scans where color coded to represent body mass and external air. These coded images were assembled to make a 3-dimensional reconstructed image of the real Phantom Monkey. This mathematical model of the phantom will increase the speed and reduce the cost of dosimetery research within AL/OER.

LASER RADAR (LADAR) IMAGERY ANALYSIS TASK

Kimberly N. Cabral
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Abstract

Two tasks were undertaken in the analysis of ladar imagery. The first dealt with ladar data from a JAWG Captive Flight Test. Several flights containing Small Smart Bomb (SSB) and panel board targets were studied using a program which showed the data in terms of reflectance and range imagery. The objective was to determine the controls as well as the quantity and quality of useful data. It was observed that much of the data was of low quality, being that several of the images were dark and/or had excess noise.

The second task was materials data extraction. Material characteristics were analyzed so variations in reflectance data could be determined. The parameters considered were channel, field of view, discriminate function, and azimuth/elevation angle. Materials were viewed and extracted via a program designed for that specific function. Overall conclusions as to the reflectance results of the second task have yet to be drawn.

A STUDY MEASURING THE ACCELERATION OF VIBRATING STRUCTURES USING A MICROPHONE

Sarah C. Calvert
Yellow Springs High School

ABSTRACT

Fatigue testing at high temperatures is becoming an important area of study, because of the need for increased durability of aircraft structures. Measurement methods that can be used in high intensity, high vibration areas at high temperatures will help designers predict and control cracking and other failures and ensure safe inexpensive flight vehicles. This report describes a method of using a non-contacting microphone and the sound radiating from a structure to define the surface acceleration. Test data are correlated with an accelerometer to determine that the relative accuracy of the use of a microphone is within 2 dB.

AN INVESTIGATION INTO RED DYE CONTAMINATION OF AVIATION FUEL

Shannon M. Campbell
Carroll High School

ABSTRACT

Research was conducted to investigate how red dye contamination in aviation fuel affects the thermal stability of the fuel. A thermal oxidated test was performed on aviation fuel with and without the dye contamination by researchers in the fuel industry. The data was collected by an international coordination council. Several samples were run with different concentrations of dye and each sample's breakpoint temperature, test pressure, and color was recorded. An analysis of the data showed that the dye may not be the sole factor in the degradation of the thermal stability. High sulfur levels acquired from diesel fuel traces, or carbon and/or dye deposits left on the filter may be responsible for the lower breakpoints of the fuel.

The Synthesis of 3-Oxaquadricyclane

Lillian A. Capell
Quartz Hill High School

Abstract

During the summer of 1996 at Phillips Laboratory, Edwards Air Force Base, the synthesis of 3-oxaquadricyclane was studied. 3-oxaquadricyclane is synthesized from the photolytic conversion of 7-oxanorbornadiene, which was synthesized via the Diels-Alder Reaction. 3-oxaquadricyclane is a strained ring hydrocarbon which is of interest because it can be used as a rocket fuel additive. 3-oxaquadricyclane is also being researched because it decomposes to form an oxepin as an intermediate which has optical absorption. Since 3-oxaquadricyclane has to be made in the laboratory many techniques were used including distilling and deoxygenating fluids as well as the preparation of sodium amalgam.

CORRELATIONS OF BODY COMPOSITION AND VO2 MAX

Carolyn K. Chen
Douglas MacArthur High School

Abstract

This project was designed to determine the correlations of body composition and maximal oxygen uptake (VO2 Max), comparing skinfold estimates and results of a treadmill test. The hypothesis is that a person with a lower percentage of fat and a higher percentage of lean mass will have a higher aerobic capacity, or VO2 Max.

The method of measurement for body composition was an application of a Lange skinfold caliper to estimate a percent body fat. Subjects also performed a treadmill test to measure their aerobic capacity (VO2 Max), for which they ran on a treadmill until they reached complete exhaustion. A comparison was made on various factors of the subject, including percent body fat, weight, height, VO2 Max (per kg of body weight), VO2 Max per lean body mass, age, weight of lean body mass, and fat weight.

The data showed that higher percent and weight of body fat correlated with VO2 Max. This corroborates data that suggests the more weight one had, the lower the VO2 Max. The last significant result was the comparison of analyzing one's aerobic capacity through the measurement of VO2 Max of body weight and the VO2 Max of lean body mass. The data showed that the VO2 Max per lean body mass probably measures one's aerobic capacity more accurately than the measurement of VO2 Max of body weight. The higher the percent body fat and the lower the percent lean body mass was associated with a lower maximal oxygen uptake (VO2 Max.)

A STUDY OF THE INFLUENCE OF RELATIVE LOADS AND G-FORCES ON ELECTROMYOGRAPHIC ACTIVITY

Lenis Chen

High School Apprentice
Armstrong Laboratory: AL/CFBV

Abstract

In this study, electromyography was used to measure the voltages of four muscles in the neck area: the left sternocleidomastoid, right sternocleidomastoid, left trapezius, and right trapezius. The purpose of this study was to predict the presence of an extra weight in a helmet (a "loaded" helmet) by analyzing EMG data, and to compare the levels of EMG activity at varying gravitational forces. A human centrifuge carried subjects up to 9 G. Statistical analysis found significantly greater muscle activity at higher G levels, but a reliable method for predicting a loaded helmet was not achieved.

PROGRAM TO DETERMINE STATIC FORCE AND MOMENT BALANCE CALCULATIONS

Phillip A. Chockley III
Shelbyville Central High School

Abstract

Both hypersonic and supersonic ground tests were studied. Testing involves placing scaled down aircraft such as space shuttles or missiles in a wind tunnel. Inside the tunnel, air is blown over the model at speeds ranging from Mach 1.5 to Mach 10. While wind is blowing, the model can be moved to many different positions which create different aerodynamic forces and moments. These forces and moments are measured by a balance located inside the model. The balance measures the forces and moments by monitoring changes in resistivity in the balance circuit and recording the change in electrical current which is converted in a term called raw counts (1638.4 counts per volt). Raw counts are converted into workable numbers in which, among other things, static force and moment calculations come from. These calculations are put into a Sixth Degree of Freedom (6DOF) database by the user to determine the stability and control characteristics of the test article.

The purpose of this work was to develop an Excel formatted spreadsheet that permits raw balance data to be converted to engineering units. The primary use of the spreadsheet is to perform much more easily program checks for the static stability engineer to ensure programs developed for force and moment data are correct. The format permits easy input and output information on force balance to be readily checked . The program uses matrix inversion to convert raw data to engineering units and then transform coefficient form in a variety of axis systems.

August 1996

Neural Networks and Digital Image Processing

Christopher R. Clark

Abstract

The areas of study presented are neural networks and digital image processing. These topics are explored using different approaches to determine their potential for use in future military sensor technology. Raw data taken from existing sensors was used to test the ability of conventional digital image processing techniques and neural networks to isolate and recognize potential targets in the input image.

The first task of the project involved porting an existing sensor model from Microsoft Excel to MathWorks' MatLab and then creating a Graphical User Interface front end for the model using Microsoft Visual Basic. This was to gain knowledge about the capabilities and programming languages of MatLab and Visual Basic which would be utilized throughout the project.

The next two tasks of the project entailed performing digital image processing and neural network processing on sensor-produced images for target recognition. The first of these tasks employed an Image MultiSpectral Sensing System, spectral deconvolution, and neural network filtering. The second task used Laser Radar and Pulse-Coupled Neural Networks.

A STUDY OF THE VERTICAL SHIFTS IN SCENE PERCEPTION MEMORY

Esther I. Resendiz
W.H. Taft High School

Abstract

Two sets of scene photos, close-ups and wide angles, were analyzed for vertical shifts in the scene perception memory of the people who drew them. The original photos were those used by Intraub and Richardson (1989). In that study students examined each picture for 15 seconds and were told to redraw the pictures exactly as they remembered them. For my research, I identified common points between the originals and the drawings that the subjects had created. I then measured the vertical position of each point with respect to the middle of each picture. I did this for both the close-ups and the wide angles. I then compared each of the drawings to the originals. I found that, generally, the subjects contracted the objects in the pictures they drew and also had a greater tendency to shift objects in their scene perception memory downwards rather than upwards.

THE PRODUCTION OF CARBON COMPOSITE GRID STRUCTURES
UTILIZING AN AUTOMATED PROCESS

Rebecca Cohen

Abstract

As carbon composites strive for new growth and acceptance within the scientific community, new problems arise and need to be solved. One of these problems is the lack of ease in large scale manufacturing carbon composite structures with underlying support grids. The grid is necessary as it lends increased strength with minimal addition to the original weight. In order to find a process that could be shared with industry and used in further government enterprises, extensive research was done during the production of the first gridded, carbon composite shroud.

STAGNATION PRESSURE LOSS IN ROCKET COMBUSTION CHAMBERS

Jennifer Counts
Franklin County High School

Abstract

Rocket performance computer models require combustion chamber stagnation pressure as an input. Typically, however, only injector face pressure is measured. Due to irreversibilities generated in the combustion process, the combustion chamber stagnation pressure is lower than the injector face pressure. Rocket combustion texts by Sutton and Hill & Peterson develop constant specific heat relations for the flow in rocket combustion chambers of various geometries. These constant specific heat relations include the calculation of stagnation pressure loss. The later versions of the NASA Chemical Equilibrium and Applications code include the options of computing combustion chamber flow in both infinite and finite area combustion chambers. In this report I solved the constant specific heat relations using Newton's method to determine the ratio of the combustion chamber stagnation pressure to the injector face pressure as a function of contraction ratio. This was done for various values of the ratio of specific heats. The NASA code was executed for seven different fuel/oxidizer combinations at four different injector face pressures and at three different mixture ratios. The equilibrium results were also plotted in the form of the ratio of the combustion chamber stagnation pressure to the injector face pressure as a function of contraction ratio. The pressure ratio for each fuel combination, pressure, and mixture ratio were practically indistinguishable for all the equilibrium calculations. Therefore, I curve fit the equilibrium results to arrive at an analytic expression for the pressure ratio as a function of contraction ratio regardless of fuel/oxidizer combination, mixture ratio, or pressure. The analytic expression is within ±1% of the equilibrium calculations for all contraction ratios and within ±0.25% for contractions ratios greater than two.

Maximal Length Sequences and Circuit Development

Allyn Crowe

Abstract

During my tour this year I did many different tasks, but I concentrated on three. The first was designing a circuit and carrying it through most of the development stages. The second was modifying my program from last year. And the third major area of study was in computer repair and upgrading. I also used different computer programs in the lab area. Including Microsoft Word, Lab-View, Visio Technical, and Matlab. In the Appendixes are graphic aids.

Polymerization Mechanisms for Electrodeposited Polypyrrole

Aaron Davis
High School Apprentice
Fuzes Branch
Wright Laboratory Armament Directorate

Abstract

Experiments were performed to determine possible mechanisms for the electropolymerization of the conductive polymer polypyrrole. The conditions required for electrodeposition of polypyrrole support electrolysis. It was conjectured that the hydrogen ion concentration around the growing polypyrrole affects the conductivity of the film. An electric field with positive or negative potential was used to alter the hydrogen ion concentration. The resulting conductive polymer films were then measured for conductivity and thickness.

MULTIPLE QUANTUM WELLS IN THE SEMICONDUCTOR MATERIAL $GaAs/Al_xGa_{1-x}As$ and COMPUTATIONAL CHEMISTRY

Cindi L. Dennis
Beavercreek High School

Abstract

P-type multiple quantum wells were grown onto a substrate using molecular beam epitaxy. The samples were cut and etched and gold wires were soldered onto the sample using indium contacts. Then, the sample was mounted inside a vacuum chamber and cooled down to 9K for testing. A long-wavelength infrared beam was used to excite the holes in the sample so that its photoresponse could be measured. The results were then analyzed to determine which theory best matched the experimental data.

Computer generated modeling of compounds and their interactions with other molecules has seen increased research in recent years. This approach allows the investigation of the properties of a compound without actually going through lengthy laboratory procedures. Modeling provides the ability to analyze a compound and determine if it will meet the specific requirements to form a new material. For example, this method allows researchers to determine through a computer model whether or not a dye will bond with a peptide so that it can be layered onto safety glasses and still absorb certain wavelengths of radiation. Computer modeling eliminates lengthy laboratory time performing experiments searching for the proper material.

Exhaust Fan Measurements with a Wedge Probe

Mark Fecke

Abstract

The measurements that were taken of the exhaust fan using a wedge probe helped to corroborate the data received from the PIV system. From that final analysis, it was found that the fan was stalled in the original configuration based on the flow angle readings. The fan came fully unstalled when the hood was taken off. The flow was further increased when the inlet screen was removed as seen by increased velocity (or pitot pressure). A description of the inlet and outlet velocity and flow angle was obtained with the fan operating in the high flow condition which can be used by PIV researchers for comparison with their results. The axial velocity and flow angle can be compared in **Appendix A**.

Data Analysis for Redesign of the
105mm Blast Diffuser

Landon W. Frymire
Laurel Hill School

Abstract

A more advanced diffuser is needed by the Air Force for use on the AC - 130 Gunship's 105mm gun. To fill this need, blast overpressure tests were conducted on three types of diffusers and a bare muzzle without a diffuser. The three types of diffusers tested consisted of a baseline diffuser (currently in use), an extended diffuser with holes, and an extended diffuser with a shroud covering the holes. A blast arena was set up around the muzzle of a 105mm gun, which is mounted on a gun truck. This arena consisted of fifteen free air probes designed to record blast overpressure signatures. After the raw data from the tests was recorded, it was then condensed in order to place emphasis on the initial peak pressure. Comparisons of the refined data will enable designers to develop a new diffuser for the AC - 130 Gunship.

Consultation Resources

Christopher C. Garcia
Edgewood High School

Abstract

This summer my tour was at AL/OEBQ in the Air Quality Branch. Their main purpose is to make sure the Air Force is in compliance with the Clean Air Act, local, state, and federal regulations. Sometimes members of the staff will go (TDY) to an Air Force Base to collect ambient and source samples. Ambient samples are taken from the open air while source are taken from a specific location such as a smoke stack. Other times they will answer questions over the phone, often the answers will require some research. There are many documents such as technical reports (TR.) and EPA documents that assist the staff. This summer I organized those documents in a database, and organized them by placing them in easy to see binders.

THE CREATION OF MOVING AND STATIONARY ACQUISITION AND RECOGNITION AND INFARED VISUAL DATA WEB PAGES

Jenny R. Garringer
Miami Trace High School

Abstract

The Moving and Stationary Target Acquisition and Recognition (MSTAR) and infrared visual data images were converted to various formats and then placed on a web page. The creation of the MSTAR web page started by transferring photographs of 14 targets from a PhotoCD, using a Silicon Graphics Indy machine. These images were reduced in size and resolution. They were then placed onto a web page using Hypertext Markup Language (HTML.) The infrared visual data images were converted to the JPEG format using NIH Image and GIF Converter on a Macintosh computer. These images were also put onto a web page using HTML. The conversion of all images took a long time and was very tedious work. I learned a great deal about HTML and the creation of web pages. These are things that I probably would not have learned without this program.

ELECTRICAL AND OPTICAL CHARACTERIZATION OF STRATEGIC INFRARED DETECTORS IN BENIGN AND RADIATION ENVIRONMENTS

Erica S. Gerken
Manzano High School

Abstract

The Infrared Devices Laboratory in the Space and Missiles Technology Directorate of the Air Force Phillips Laboratory, Kirtland AFB, NM is tasked with non-partisan characterization of infrared detectors and focal planes for Air Force programs. Both electrical and optical performance characteristics of the detectors are tested, the data is analyzed, and conclusions are drawn about the material. This information is then fed back to the manufacturer, forming an iterative loop of material, and therefore detector improvement. These tests are performed in both non-radiation and radiation environments, providing insight into the effective lifetime of these detectors in a natural radiation environment.

NEUROPHARMACOLOGICAL CHARACTERIZATION OF G-INDUCED LOSS OF CONSCIOUSNESS

Lori J. Gilliam

Abstract

In order to unlock the secrets of gravitational induced loss of consciousness (G-LOC), the central nervous system's (CNS) regulators of consciousness were studied. Animal experiments were conducted to determine if pharmacological intervention could help prolong G-LOC induction time. Two experimental groups received a combination of cholinergic and adenosine compounds intended to prolong the G-LOC induction time. Moreover, the latter group was also treated with known cerebroprotective agents. Both treated groups resulted in the maintenance of prolonged EEG at all frequencies, which is suggestive of useful consciousness. Although the administration of the cerebroprotection compound had a severe sedative effect, it significantly reduced the amount of neurodegeneration.

A STUDY OF THE LUBRICATING PROPERTIES OF COMMERCIAL LUBRICANTS WITH RESPECT TO RELATIVE HUMIDITY

Douglas S. Ginger
Centerville High School

Abstract

The effectiveness of lubricants on the wear of steel in a controlled environment was studied. To simulate a system experiencing relative motion, a Cameron-Plint tribometer was used along with highly polished steel disks and cylinders. The environmental relative humidity was strictly controlled and varied between test runs from one to ninety-five percent to determine the impact humidity has on the wear and frictional properties of the lubricant. With the temperature kept at a constant 150°C throughout the tests, experimental results indicate that a significant correlation exists between the relative humidity of the air around the sample with friction and wear.

Robert Glaser

ABSTRACT

Testing has been conducted on a generic inlet and diffuser test section that was designed to simulate the air flow delivery to a combustor sector. The airflow exiting the diffuser must have a uniform velocity or momentum profile. This momentum or dynamic pressure leaving the diffuser has a tremendous impact on the combustion air entering into the combustor and thus the operation of the combustor. The ununiformity of the air entering into the combustor can manifest itself in poor combustor stability as well as a decrease in combustion efficiency and an increase in flame length. Velocity measurements using a pitot static probe have been obtained at various locations in the test section to determine the distribution of air through the rig. The probe was traversed to obtain a full compliment of data for which to interpret the trends. Based on the data obtained, adjustments were made to condition the flow to effect the flow distribution of air entering and exiting the diffuser.

DEVELOPING AN AUTOMATIC NEURAL NETWORK TRAINING ALGORITHM AND USING NEURAL NETWORKS AS CIRCUIT SIMULATOR MODELS

Stephen M. Govenar
Beavercreek High School

Abstract

The HP Libra circuit simulator has a feature called Senior that enables user-defined elements to be created and used in the program. A neural network training program developed last year, named nnw, was modified to output C source code for a Senior element and for a standalone neural network program. An automatic neural network training algorithm was then developed, and the nnw program was modified to include this.

INFORMATION ON THE INTERNET and PEM TEST CIRCUIT DESIGN

Daniel Grabski
Holland Patent High School

Abstract

I was involved in both software and hardware projects for my research. I wrote HTML code for the Rome Laboratory Electromagnetics and Reliability World Wide Web (WWW) pages. In writing these pages, many features of Netscape-type browsers were used, including the ability to accept JavaScript commands and the ability to create frames. By editing MoleculeViewer, a Java program for displaying and rotating a molecular model, I was able to create a realistic model of a molecule that can be rotated and viewed on a WWW page. For hardware research, I utilized a LTX77 Automatic Test System to test LM2904 dual opamps from different manufacturers for in-house plastic encapsulation microcircuit (PEM) research. I also designed a circuit and program to be used with the LTX77 to test up to four LM324 quad opamps at a time to collect data for field PEM research in collaboration with the Army.

Observation of deGaussing Through Repeated Thermocycling
of Samarium Cobalt Magnets

Shaun R. Guillermin
Chaminade Julienne High School

Abstract

An experiment was designed to study the deGaussing of Samarium Cobalt magnets when thermocycled repeatedly from room temperature to 400 degrees Celsius. At specified intervals, certain magnets will be removed from the test bed and analyzed for loss of Gauss strength. Elapsed time for the project is three thousand cycles, or approximately one hundred and sixty seven days. A preliminary study is presented, detailing design, construction and operation of the test apparatus. Plots of initial heating and cooling cycle tests, as well as actual thermocycling data from the test bed, are included. At this early stage, sufficient data has not been accumulated for publishing.

"EASY REFERENCE"
PSYCHOLOGICAL REFERENCE PAGE CREATOR

Aaron R. Hamid
Robert G. Cole High School

Abstract

"Easy Reference" is a program that, given a partial or complete psychological citation, searches a database of psychological references and displays matches to the user who can subsequently insert said references into an automatically created reference page. This program takes the tedium out of creating reference pages based on citations within theses. "Easy Reference" was written in WordBasic and utilizes SQL (Structured Query Language) to search an Access database located on a public network drive. Possible extensions of "Easy Reference" include a document "scanner" which searches through a document and automatically creates references for every recognizable citation, and an advanced search search which finds references in the database containing a combination of Author, Title, Date, and Publication.

IN-VITRO SIMULATION OF PHYSIOLOGIC AORTIC PRESSURE AND FLOW PROFILES

Gregory T. Hannibal
Northside Health Careers High School

Abstract

A Cardiovascular Dynamics Simulation Modeling (CDSM) System was developed to simulate aortic pressure and flow waveforms of *in vivo* measurements in Rhesus monkeys. The CDSM system consists of a programmable pump and motion controller, a computer data acquisition system, and a closed flow loop assembly. Physiologically equivalent aortic pressure and flow profiles were reproduced in the CDSM system by matching time and frequency domain characteristics of the CDSM system to the Rhesus data. Model and hemodynamic parameters were matched with varying success, as heart rate and mean aortic pressure agreed to within one percent, while stroke volume, cardiac output, systolic and diastolic aortic pressures, and pulse pressure showed marked deviation (12.3% - 110.6%) from target values. Computational errors and limitations of the experimental model were responsible for some of these differences. Overall, the CDSM system was determined to be an acceptable mechanical model of the cardiovascular system for the testing and evaluation of electrical analog models of the arterial system.

NEUROPSYCHOLOGICAL TESTING OF PILOTS

Daniel L. Hardmeyer
James Madison High School

Abstract

Neuropsychological testing is administered UPT pilots, the normal pilot population, and certain special cases. Neuropsychological testing is a factor in the selection of pilots, is used when pilots are having certain problems, and is given under other special circumstances.

NEODYMIUM FIBER LASER

Doug Havlik
Albuquerque Academy

Abstract

A neodymium-doped silica optical fiber laser pumped by a 817 nanometer (near-infrared or near IR) laser diode was built and successfully lased. Construction of this laser consists of two critical steps : first, aligning the diode beam so that it is coupled into the three meter fiber optic, and second, aligning the mirrors on either end of the fiber to create a laser cavity. Each of these steps has its own difficulties, including obtaining an "ideal" beam from the diode that will couple efficiently into the fiber. After building the laser, one photodetector had to be aligned for each of the two polarizations of light separated by the polarized beam splitter. This laser is an instrument for experimentation in chaotic optical systems.

THE STUDY OF THE NEOTAM COMPUTATIONAL MODEL

Angela C. Helm
Carroll High School

ABSTRACT

This paper involves research that was done on the NATO NEOTAM (NATO electro-optic target analyzing model) computational model. This model is set in a Khoros Cantata environment. This platform uses the GUI (Graphical User Interface) format. It allows the user to interact in a graphics atmosphere with the information that deals with the NATO model. Unfortunately, this program is not yet user friendly. NEOTAM phenomonologists are trying to develop ways to make the program easy for unexperienced users to run the model successfully. The purpose of this research was to use the model, and as an unexperienced user, comment on parts that were not user friendly. In order to do this successfully, a basic learning of aerial targeting and what it involves had to be attained. Numerous weeks were spent studying the concepts of infrared aerial targeting, and it's application to modeling and simulation. After this was done, this acquired knowledge was applied to the NEOTAM model. Comments were made on how this program could be improved. The primary work done was to design GUI style glyphs (a way to portray information graphically) with the information that existed in a text form.

Laser Firing Control System

David B. Hernandez
Freeport High School

Abstract

The Instrumentation Technology Branch (MNSI) of the Wright Laboratory Armament Directorate is involved in developing and evaluating new and better ways to accurately depict warhead/target interaction. One of these ways is by developing and making holograms of the warhead as it interacts with a target. Current methods are inadequate in providing reliable data on such things as the fragment mass, shape, orientation, and velocity. A new method that has been developed is a holographic technique to capture 3-dimensional images of the warhead/target interaction and the ensuing results of that interaction. The end product is a cylindrical 3-dimensional image that can be tilted, rotated, and digitally photographed to obtain the best possible image for analysis.

The aim of this project is to develop a computer program that automatically initializes, runs and controls all of the equipment, primarily the ruby pulse laser (see Figure 2 in back), used to capture and record the image of warhead/target interaction onto holographic film. This project is required to provide a good, understandable interface for a user to control the equipment used in the image capturing process. Without this interface, valuable man hours are spent using an old, outdated, and inadequate computer program to control the laser firing control system. The program currently in use is not as effective nor as efficient as a program written in a newer programming language would be in capturing and recording the necessary data of warhead/target interaction. The goal of this project is to update and rewrite the existing interface currently in use as the laser firing control system.

AN INVESTIGATION INTO RED DYE CONTAMINATION OF AVIATION FUEL

Anna Solveig Hill
Carroll High School

ABSTRACT

Research was conducted to investigate how red dye contamination in aviation fuel affects the thermal stability of the fuel. A thermal oxidated test was performed on aviation fuel with and without the dye contamination by researchers in the fuel industry. The data was collected by an international coordination council. Several samples were run with different concentrations of dye and each sample's breakpoint temperature, test pressure, and color was recorded. An analysis of the data showed that the dye may not be the sole factor in the degradation of the thermal stability. High sulfur levels acquired from diesel fuel traces, or carbon and/or dye deposits left on the filter may be responsible for the lower breakpoints of the fuel.

CONSTRUCTING AN INTERNET HOME PAGE USING HYPERTEXT MARKUP LANGUAGE

Jason E. Hill
Shelbyville Central High School

Abstract

HyperText Markup Language (HTML) and the construction of a home page were studied. The home page was constructed for the Optical Diagnostics Self-Directed Team, an AEDC technology group. To construct the home page HTML was used as is standard in all present day websites. Many hours of research of HTML were done to learn the language in order to construct a well written and appealing home page. Then the actual home page was constructed, perfected, and updated through the remaining time period. The home page was designed to be informative, elegant, and resourceful in nature and it also performs the function of giving the team a sense of unity and identity.

The EPIC Penetration Event Generator (EPEG)

Dann Holmes

Abstract

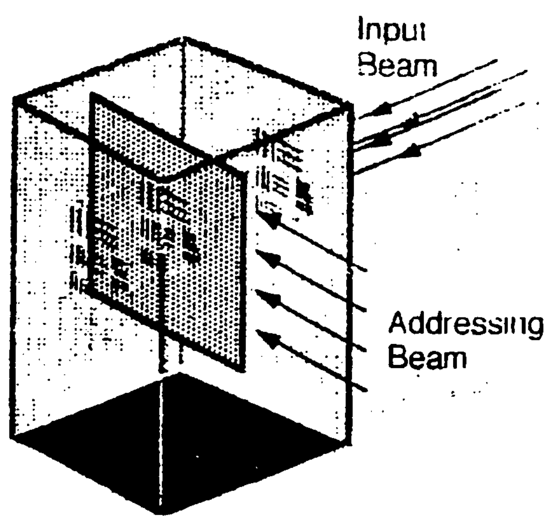
My project this summer was to write a graphical user interface (GUI) for the EPIC hydrocode. To do this, I had to write a program for Windows in Visual Basic 4.0. The program that I wrote makes it easy to set up a typical penetrator/target scenario. By having only the most important and useful options that an EPIC user needs, the program expedites the input creation process. The program that I wrote successfully creates an input deck that any user could use to model a scenario. Hopefully in the future, I can expand upon this program and make it more robust, with more options and scenarios.

MEMORIES OF THE FUTURE:
A STUDY OF BIT-ORIENTED OPTICAL MEMORY

Nicholas Hrycan
Thomas R. Proctor Senior High School

Abstract

Aspects to consider when developing a new memory system are capacity, access time, data transfer rate, storage persistence time, and cost per megabyte. Current two-dimensional (2D) memory devices store information as bits on a flat surface called a bit plane. As a result, this information is retrieved from the bit plane bit by bit. On the other hand, three-dimensional (3D) optical memory devices take it a step further by storing the information by entire bit planes and stacking them in the third dimension. Consequently, one memory operation is performed on the entire bit plane, resulting in a tremendous memory bandwidth increase over existing 2D memories. The figure below shows one of the bit planes in the cube. Image storage and retrieval is one area where improved storage technologies are required. This paper will present Bit-Oriented (a.k.a. two-photon) optical memory by breaking it into Theory, System Operation, and Problems and Possible Solutions.



SOLAR THERMAL PROPULSION FROM CONCEPT TO REALITY

Karl J. Iliev
Antelope Valley High School

Abstract

Solar thermal propulsion's multiple facets were studied and its application was looked at briefly. The efficiency and capability of select solar propulsion components were tested. During my brief tenure, several small projects were begun, some completed. A calorimetry experiment tested the power output of the existing rigid concentrator. The process of constructing and testing an inflatable concentrator for slope errors and its power output was initiated. Slope errors will be measured using laser ray tracing techniques. A shutter was designed to quickly allow or block the passage of light onto the test subject in order to take more accurate measurements. Finally, different absorber, thruster, and propellant types and combinations were studied. Phillips Laboratory has been testing several different components in various important areas over the past 13 years. The ground tests will eventually provide enough information to build flight hardware. This culmination into several flight tests is the next step to reality of solar thermal propulsion.

The Study and Application of
C++ Programming

Eric W. Inge
Rutherford High School

Abstract

The computer programming language of C++ was studied. Along with assisting with other tasks in a robotics laboratory, the best course of action appeared to be to learn a high - level language since no resources other than computers were available to research with and all of the work done was through computer programs. A "Teach Yourself" book was thoroughly studied through reading, typing in sample programs, and by answering review questions. Knowledge of the language was acquired and then applied toward assisting in a program to operate the Automated Ordnance Excavator, which was undergoing the process of being changed into a vehicle operated by remote control by a laptop computer.

DETERMINATION OF SKIN:AIR PARTITION COEFFICIENTS FOR HUMAN STRATUM CORNEUM

Nafisa Islam
Centerville High School

Abstract

Skin:air partition coefficients were studied for three different chemicals in relation to the human stratum corneum at three different temperatures. A target 10000 ppm concentration of dibromomethane (DBM), chloropentafluorobenzene (CPFB), and perchloroethylene (perc) vapors were separately passed over the same sample of human stratum corneum in the Thermal Gravimetric Analyzer (TGA cell). Each exposure was conducted at 27 °C, 32 °C, and 40 °C to determine the effect of temperature on the partition coefficient. It appears that higher lipophility in a chemical corresponds to increased partition coefficients. Results also indicate that the partition coefficient decreases with temperature, indicative of the significant role played by gas thermodynamics in chemical uptake by human skin. The decrease may best be modeled by an exponential decay function as opposed to a linear model, as a logarithmic transformation of the data yielded clearly linear and parallel graphs, but more data is needed to decide this conclusively.

MAGNITUDE MEASUREMENT OF ELECTROMAGNETIC FIELD INTENSITIES USING AN INFRARED MEASUREMENT TECHNIQUE

Sandra L. Jablonka
Oneida High School

Abstract

Electromagnetic (EM) field intensities were studied, using an IR (Infrared) measurement technique. Sensitive to EM radiation, Carbon loaded Kapton paper, was used as a detector. It increases in temperature with a direct relation to the intensity of the radiation. The radiation is absorbed by the detector which causes the ambient temperature at the surface of the paper to rise. An IR camera used in conjunction with AGEMA Thermovision software allows the various temperatures on the paper to be identified and to be displayed on a computer screen. The camera was placed on the opposite side of the paper as the horn. The paper was radiated with EM radiation from the horn antenna and the temperatures were measured using the IR camera. The purpose of the study was to quantify the errors that can affect the intensity and repeatability of the EM field.

A Study of Acoustic Wave Propagation in Non-Equilibrium Plasmas

Andrew J. Jutte
Northmont High School

Abstract

The properties of acoustic shock waves produced in non-equilibrium plasma were studied. Gas discharges were created using currents of 50 and 100 miliampres in a vacuum tube under varied pressures. Acoustic shock waves were produced by a spark gap at one end of the tube. The effects of the plasmas on the shock waves were measured using a laser and a photo-acoustic deflection measurement device. Experimental results show shock wave amplitude dissipated in weakly ionized non-equilibrium plasmas. Shock wave dissipation seems dependent on fractional ionization.

PSYCHOPHYSIOLOGICAL DATA: EYEBLINKS, HEART RATE, AND RESPIRATION

Kelly M. Keish

Vandalia-Butler High School

Abstract

Psychophysiological data involving eyeblinks, heart rate, and respiration were collected and analyzed. All data were obtained using electrodes on the surface of the skin of human subjects and collected while the subjects completed a Multi-Attribute Task Battery in a simulated environment. The data was graphed and observations were made.

HYPER TEXT MARKUP LANGUAGE

Nick Klosterman
Chaminade-Julienne Catholic High School

ABSTRACT

Hyper Text Markup Language (HTML), a computer language used to communicate data on the Internet, was learned so that creation of HTML pages for the Model Based Vision Laboratory (MBVLab) could be made. After learning HTML, we developed two sites on the Internet for the MBVLab. These sites used a type of interactive display for presenting the data and letting the user access it.

SPELL CHECKING WITH A DIRECTORY-TRIE IN PROLOG

Matthew A. Lam
Proctor Sr. High School

Abstract

A spell checking program using the Amzi! Prolog programing language was constructed, utilizing directory-trie structures to store the database of words. Words are placed in lists under directories and file names corresponding to the letters in each word. When the spelling of a word is checked, the file containing the word (if it exists in the database) is consulted and checked for a match. If there is an error, letters are manipulated in an attempt to find a close match, which would hopefully be the intended word. The final program has an error rate of 1.112%, and a speed of 1.354 words per second. This is considered to be slow, and is the consequence of loading large lists of words into memory.

Combined Effect of Gravity and Geomagnetic Field on Crystal Growth

Abstract

A space experiment was conducted in Shuttle Discovery in 1988 to investigate the gravitational effect on crystal growth. The observations, described briefly in the Chemistry textbook (Kotz and Purcell, "Chemistry and Chemical Reactivity," 1991) I studied last semester, show that crystals grew uniformly throughout the solution and also uniformly on a membrane at the center of the container. By contrast, in similar experiments performed on Earth, crystals did not grow uniformly in the solution nor on the membrane. However, it remained unexplained why crystals are able to grow uniformly in a rather weak gravitational field. Motivated by the space shuttle experiment, I have carried out some experiments in laboratory on crystal growth. The design of my experiments is based on a hypothesis that the growth of crystals is affected by not only gravity but also the geomagnetic field. A solenoid, that is, a long helical coil with many turns, was made to produce magnetic fields with magnitudes comparable to the local Earth's magnetic field. Changing the applied currents in the solenoid varies the intensities of the produced magnetic fields. Containers with chemical solutions were placed near the center of the solenoid to grow crystals. Two kinds of chemicals, aluminum potassium sulfate and monoammonium phosphate, were used to study the combined effect of gravity and the geomagnetic field on the growth of crystals with metallic elements and non-metallic elements, respectively. The preliminary results of my experiments have confirmed the hypothesis. The uniformity of the crystal growth and the size of the grown crystals can indeed be controlled by the combined effect of gravity and the magnetic field. My hypothesis supported by my experiments can explain well the observations of previous shuttle and laboratory experiments described in the Chemistry textbook. My future continued experiments will consider other important parameters such as the chemical density and the room temperature for a quantitative study of crystal growth under the effect of gravity and a controllable magnetic field.

AN INVESTIGATION OF CATALOGING PROCEDURES
FOR POINT SOURCES IN THE GALACTIC PLANE

Maureen D. Long
Chelmsford High School

Abstract

The Infrared Astronomical Satellite (IRAS), which flew in 1983, conducted a near-complete infrared survey of the sky at wavelengths of 12, 25, 60, and 100 μm. From this data, several infrared source catalogs were compiled, including the Point Source Catalog. One region of the sky that presented a problem during analysis of data was the galactic plane, a "confused" region. Point source extraction of the galactic plane region at 12 and 25 μm was performed using high-resolution techniques. We are transforming this data into catalogued form. This process involves eliminating repeats and spurious sources, setting signal-to-noise thresholds and other minimum criteria, and finally merging the 12 and 25 μm source lists into a final catalog. This project involved analyzing the data in several ways to determine what improvements to current cataloging processes could be made, and then making these improvements.

AN ANALYSIS OF OIL/GREASE IN WATER AND SOIL

Adriana Y. Lopez
East Central High School

Abstract

An analysis of oil and grease in water and soil samples was conducted. Water samples were measured in 500 ml flask containers with an addition of freon and Sulfuric Acid. The samples were agitated by hand and by machine for 3 minutes. After this process, the samples were extracted into 10 ml cylinders. Soil samples were weighed out and freon was added. These were stirred for 2 minutes and extracted into cylinders.

Soil and water samples were investigated for pollutants. An analysis of oil and grease was conducted. Water samples wee measured in 500 ml flask containers with freon and Sulfuric Acid added. These samples were agitated by hand and by machine for 3 minutes. After this process, the samples were extracted into 10 ml cylinders. Soil samples were weighed out and freon was added. These samples were stirred for 2 minutes and extracted into cylinders.

Enhancement of CAD Packages for Electronic and Computational Applications

Jonathan Mah

Abstract

In the field of circuit design, engineers need many tools to facilitate the synthesis and analysis of electric and electronic circuits. These tools are in the form of computer programs, which provide accurate synthesis and analysis of circuits. Computer programs can also be very expensive. However, tools such as SPICE, Matlab, and Tcl/Tk have public domain versions, which will be or already are available on the internet. Also, commercial versions of Maple and SPW are very powerful with regards to computational and circuit analysis. Matlab and SPICE have actually been integrated into one large program called TOTAL, which will be released as public domain. In order for this to happen, changes needed to be made in the code to enhance and debug the program. The enhancement regarded the "EXEC" command and how it was changed to facilitate the user. The debugging concerned the "QUIT" and "EXIT" commands as well as the "SAVE" and "LOAD" commands. Also, Tcl/Tk has been used to interface programs such as SPICE and Matlab in a windows environment. SPICE can be sourced into the Tcl shell (Tclsh); it will prompt the input and output files and run the program. It can also run in the Tk widget shell (Wish), but the input and output files must be written into the code directly. In addition to using Tcl/Tk, SPICE can be interfaced into Maple. Maple does many matrix manipulations, which is very helpful in solving mesh circuit equations. Maple also puts the results in an easy-to -read format.

EVALUATION OF ALTERNATIVE CONTROL TECHNOLOGIES

Darby Mahan
Tippecanoe High School

Abstract

Alternative control technologies may provide interfaces preferable to the traditional manual control of modern systems. The Alternative Control Technology (ACT) Laboratory is dedicated to the research and evaluation of such nonconventional controls. Various investigations are underway at the ACT Laboratory to study control based on EEG (electroencephalograph) and eye-line-of sight. The work performed in this summer apprenticeship was in support of these projects. The tasks involved 1) manipulating and analyzing data recorded from several experiments examining brain-actuatedcontrol, 2) collecting and analyzing data using a new eye tracker system, 3) generating a more tailored user manual for that system, and 4) creating a database of potential customers for alternative control technology.

APPLICATION OF WORLD WIDE WEB TECHNOLOGIES TO ENHANCE INFORMATION VISUALIZATION

Christina Maimone
Chaminade-Julienne Catholic High School

Mark Beebe
Beavercreek High School

Abstract

The vast growth in capability of World Wide Web technology has brought a new way of communicating and sharing information into many offices. The Logistics Research Division of Armstrong Laboratory is exploring the option of using these technologies in logistics efforts. In order to assist in this endeavor, this project was designed to produce an example of the many capabilities of applying Virtual Reality Modeling Language (VRML) and HyperText Markup Language (HTML) to logistics. In this project, VRML worlds and HTML pages were created and connected to each other. A variety of aspects of the two languages were introduced. As the project developed, some problems were encountered. Among these were response time, file size, and product problems. Some had solutions while others may be fixed at a later time when solutions are discovered. In an effort to relate this project to logistics efforts, some examples were offered for further enhancement including aircraft maintenance manuals and training. Overall, this project was a success and can be used to learn about the many possibilities of using VRML and HTML in logistics.

THE OPTIMIZATION OF AN IMPEDANCE MATCHING TRANSFORMER FOR AN EXPLOSIVE FLUX GENERATOR AND STATIC LOAD

David R. Mandel
Niceville High School

Abstract

In order to get the best impedance match to ensure the maximum power transfer from the source to the load, the design of the transformer is critical. In order to determine the best transformer for a given source a computer simulation of an electric system was used. The simulation modeled the operation of an explosive flux compressor generator, transformer, and static load. The simulation was run with all combinations of three different variables of interest. These variables were, seed current, primary inductance, and secondary inductance. The peaks of the graphical outcomes were recorded and graphed. Then, three additional simulations were run with no transformers so that these could be compared to the runs in which a transformer was used. This paper describes transformer operation, FCG code, the simulation inputs, the results of those runs, and the conclusions that were made.

THE REMOVAL OF HAZARDOUS COMPOUNDS USING A NON-THERMAL DISCHARGE DEVICE

Michele V. Manuel
Crestview High School

Abstract

The use of a Non-Thermal Discharge (NTD) device to reduce hazardous emissions was studied. An exhaust stream which contained an overabundance of nitric oxide was used to see how much of this toxic compound could be removed. The experimental data indicates that there is a direct correlation between efficiency and power, and efficiency and the initial concentration of nitric oxide. Using less power and high initial concentrations of nitric oxide with the addition of ethanol has brought the final nitric oxide concentrations to only trace amounts. This data provides sufficient information to conclude that this is a mature and promising technology.

INSTRUMENTATION AND DATA ACQUISITION

Ruben E. Marin

Littlerock High School

Abstract

This research was conducted at Area 1-120, Phillips Laboratory, Edwards Air Force Base. It is currently the United States Air Forces Large Engine and Component Test Facility. It has been in operation for about 40 years and has seen the evolution of the American space program. Now in the dawn of a new age, this area is calm and undergoing improvements. This paper will focus on the new instrumentation, methodology and data acquisition systems being installed in 1-120, those that will make a difference in the way things are done here and the change it will make in today's Defense and Aerospace industries.

ELECTROCHEMILUMINESCENCE (ECL) SENSORS RESEARCH AND DEVELOPMENT

Alison B. Martin
Mosley High School

Abstract

Two projects involving Electrochemiluminescence were studied. First, ECL was used to determine the binding affinity between copper(II) and 3,4-diaminotoluene (DAT), 1,2-diaminoanthraquinone (DAQ), and 9,10-diaminophenanthrene (DAP). Results indicate that 1,2-DAQ and 9,10-DAP exhibit higher ECL intensity, but copper(II) has little effect on these ligands. Second, experiments were performed to characterize the natural ECL material in a tunicate (*Molgula occidentalis*). Tunicate blood pigments were studied on a fluorescence microscope and in polyacrylamide gels on a UV transilluminator. The blood cell lysate fluoresced in both cases. The cell lysate was further studied through size exclusion chromatography and tested for ECL intensity and absorbance at 325nm. The techniques suggested the natural ECL molecules to be of moderate molecular weight. ECL has numerous applications. These two studies helped to answer questions about this emerging sensor technology.

THE BIODEGRADATION OF AMMONIUM PERCHLORATE IN A FIXED BED REACTOR

Lisa A. Mattingley
Mosley High School

Abstract

The biodegradation of AP in a fixed bed reactor was examined. Ammonium perchlorate constitutes 14-70% of the components in solid rocket propellant. The widespread use of ammonium perchlorate in the manufacturing, refurbishment, and disposal have led to groundwater contamination. A fixed bed reactor allows large volumes of contaminated groundwater to be treated with removal of Ammonium perchlorate. The fixed bed reactor works by pumping in pH controlled media and an AP waste stream into an up-flow system. The anaerobic bacteria which are attached to diatomaceous earth pellets, reduce the perchlorate levels. Perchlorate concentrations were approximately 500 ppm in the simulated waste stream, 200-300 ppm exiting the reactor column and 0-20 ppm in the effluent of the holding tank. These results demonstrate that a biofilm has formed and it is reducing perchlorate.

A STUDY OF GAMMA RADIATION PRESENT IN THE ENVIRONMENT

Lila Medrano
Louis W. Fox Academic and Technical High School

Abstract

The concentration of this study was to determine the concentration of radionuclide activities present within my local environment. The instrument used to carry out this study was the Gamma Spectroscopy System. Samples of soil and water were brought into the lab and counted on the system. The counts were 10,000 seconds for each geometry (size and shape of the sample). The nuclide activities are detected by the interaction of the photon emissions (gamma rays and X-rays) with the hyperpure germanium detector.

The three radionuclides of interest were radium - 226, thorium - 232, and uranium - 238. Thorium - 232 and uranium - 238 were able to be detected by the presence of their daughter products: Ac -228 and Th - 234 , respectively. Radium - 226 can still be detected as such. The end results showed that the concentrations for the radionuclides in the samples collected did in fact coincide with the range of values set for the state of Texas.

RAID: REDUNDANT ARRAY OF INDEPENDENT/INEXPENSIVE DISKS

David J. Miller
Samuel Clemens High School

Abstract

The input/output (I/O) systems of most computers have nowhere near the speed of the central processing unit. One solution to this problem is a redundant array of independent/inexpensive disks (RAID), which can increase the speed of an I/O system by breaking apart requests and letting each disk on the array handle a part. The original five "levels" (configurations) along with several newer configurations are detailed. The two basic ways of getting a RAID system, buying one and setting one up yourself, are explained along with how to choose the best "level". Finally two projects that the Instructional Systems Research Branch is working on , XAIDA (Experimental Advanced Instructional Design Associate) and TEEM (Training Efficiency and Effectiveness Methodology), are described and how a RAID system could help them is explained.

FERROELECTRIC LIQUID CRYSTALS FOR SATELLITE COMMUNICATIONS PHASE II

Fawn R. Miller
Manzano High School

Abstract

This two year project studied the nature and operation of liquid crystals in a variety of different phases. Ferroelectric liquid crystal modulators were evaluated for use in satellite laser communications. The performance of the ferroelectric liquid crystal was measured previously by ON-OFF modulation techniques of a laser beam. Measurements were taken from 10 to 500 hertz and results indicated potential future applications.

The ferroelectric liquid crystals are capable of handling a moderate data rate. To achieve this data rate consistently, the ferroelectric liquid crystals must stay at a constant temperature. Many studies were conducted on how to cool the ferroelectric liquid crystals. The temperature controlling mechanisms created proved the crystals could be a productive satellite communication modulator.

COMPUTER APPLICATIONS FOR SPEED AND EFFICIENCY

Bud A. Miyahara
Carroll High School

Abstract

At Wright Labs, things must be done quickly and efficiently. This also applies when it comes to the use of the computers, at Wright Labs. Problems come up like shortage of disk space, slow calculating speeds and an ever present "crash" tendency. The files and programs must be manipulated in order to have the best performance out of the program. Another problem that arises is, which system, Macintosh or PC, will it perform on best? These are all problems that have to be taken care of by smart computer management.

CONVERSION AND TESTING OF THE T.E.T.A.S ROUTINES

Michael R. Munn
Coffee County Central High School

Abstract

The Turbine Engine Test Analysis Standard (TETAS) computer software is a combination of subroutines and functions commonly used when evaluating the data from the turbine engine test cells. These subroutines include functions that find maximum and minimum values, averages, and various other procedures. During the testing the engineer will input data points from the engine. This information will run through the subroutines and the results obtained will give the engineer an idea of the engine's performance. In an attempt to modernize the software, by making the routines more efficient and more transportable from one computer platform to another they are being converted from FORTRAN to C.

Writing Diagnostic Software For Photoluminescence Studies

Lewis P. Orchard
Sandia Preparatory School

Abstract

Our project was to study the wavelength emissions from optically pumped semiconductor emitters. To study the wavelengths we fired a twenty watt Yag CW laser onto the sample and recorded the fluorescence using a monochrometer. Viewing the emissions from the emitter allowed us to answer our primary question, which was to find out if the sample lased. Armed with this information we were able to evaluate the effectiveness of the emitter.

THE STUDY OF THE NEOTAM COMPUTATIONAL MODEL

Disha Jayantilal Patel
Kettering Fairmont High School

Abstract

Research was done on the NEOTAM computational model. This model is being developed by a NATO research study group to enable both expert and inexpert users to efficiently conduct R&D on electro-optical aerial targeting. The primary purpose of the research was to give feedback on how to improve the Cantata GUI (Graphical User Interface) for the NEOTAM model, so new users would be able to use the model with ease. The feedback was also being used to inform the NEOTAM phenomenologists about what needed to be done in order to improve the NEOTAM model. However, before commenting on NEOTAM could begin, the concepts of electro-optical aerial targeting had to be understood. Several weeks were spent on studying these concepts. After these concepts were understood, commenting and collecting results began. Experimental results indicated that the NEOTAM model needed improvements, so users could easily execute the model. Experimental results also indicated how Cantata was poorly installed. One example was the main library (FORTRAN 77 library) could not be found on the SUN system and had to be installed. Also, major files that were needed were not found. However, even though errors hindered the research, progress was made in some areas such as, changing the color palette and producing some data from running the sub-models SOBOAT and REP. Overall, the comments that were made will help NEOTAM model builders make NEOTAM more sufficient in the future. The comments will also help the research and development of the USAF Wright Laboratory's AEM*AT (Advanced Electromagnetic Model for Aerial Targeting), which uses much of the same technology.

INSTRUCTION IN SCIENTIFIC
INQUIRY SKILLS (ISIS)

Jennifer M. Patterson
John Marshall High School

Abstract

The *Instruction in Scientific Inquiry Skills* tutor (ISIS) is a computer program designed to teach students skills in scientific inquiry. During the 1995-96 school year, students used ISIS in conjunction with their standard science courses. Before and after the use of ISIS, tests were given to the students to measure their knowledge about science and the scientific inquiry skills. A correlation was found in comparing the scores of the ISIS users to those of the students that did not use ISIS. The users of ISIS outperformed the control students on 8 of the 9 skills.

FUEL IDENTIFICATION BASED ON NAPHTHALENE AND BENZENE DERIVATIVES

Amanda Perrie
A. Crawford Mosley High School

Abstract

This study examined the gas chromatographic/mass spectral results of fuel samples to determine if fuels could be classified, even after weathering, according to peaks that corresponded to a series of naphthalene and benzene derivatives. The GC/MS results were used to train the computer using a 3-layer back-propagation neural network that would classify the fuel samples. After experimentation, the results showed that the naphthalene and benzene derivatives, excluding 1-ethylnaphthalene, were too volatile to withstand the weathering process. The mass of the compounds decreased to the point where the trained neural network could not identify with repeated accuracy the fuel classifications.

Using Spreadsheets and Programming in a UNIX Environment

Anthony Perritano
Sauquoit High School

Abstract

The Rome Laboratory was conducting the Core Business Audit , this was the examination of all business activities on the Griffriss Air Force base complex. The Core Business Audit included the source of funding, core business activity, directorate used, type of funding and many other headings. Graphs were made representing comparisons and contractions. This was complied using Microsoft Excel version 5.0. The Image Product Archive (IPA) team also under went a revision of their web browser from version 2.3 to 3.0. The help file system was upgraded and reorganized using UNIX systems. Hyper text Markup Language (HTML) programming was used, embedded in C source code. The IPA Interface Control Document was put on-line using HTML programming on UNIX based systems. For the Import Product section of the IPA browser, functions were written in C programming language. These tasks were performed with the collaboration with others. The functions checked the input of the user and return error messages if the input was incorrect. The functions created were a format check and a range check of the input.

A STUDY ON DETECTION AND MEASUREMENT OF ATMOSPHERIC BACKSCATTER USING DIRECT DETECTION BACKSCATTER LIDAR

Neill W. Perry
Crestview High School

Abstract

A LIght Detection And Ranging (LIDAR) system sensitive to atmospheric backscatter was developed and tested. A protective, aluminum casing was also designed to shield the system from electromagnetic interference, dust, and light. The system was tested by measuring atmospheric backscatter off a nitrogen fog was measured with the system in a controlled environment.

DIGITAL SIGNAL PROCESSING OF MAXIMAL LENGTH SEQUENCES

Michael D. Powell
Beavercreek High School

Abstract

Pseudorandom sequences and digital signal processing were studied. The Berlekamp-Massey algorithm was used for determining the generating polynomial from a maximal length sequence. This algorithm and the necessary input and output routines were programmed for a digital signal processing board. The program was successfully tested and its operating ranges determined. A circuit for regenerating the maximal sequence from the program's output was also designed.

DEVELOPMENT OF WEBPAGES

Shaun Power
Heritage Christian School

Abstract

The World Wide Web is the best way to acquire information in the modern world today. This summer I helped participate in an effort, dedicated to making MSTAR target photos and IR imagery available on the World Wide Web. Using HTML (Hyper Text Markup Language), me, and other high school apprentices, designed and composed the two pages necessary to present the given information. By using frames and tables, we presented the images and photos in a very uniformed way. Also by using frames and tables, the pages were constructed in a way that more information could be added to them at a later date.

DIMENSIONAL CHANGES AFFECTING HS50 AND HA50HS IRON-COBALT ALLOYS DUE TO ANNEALING

Angela C. Rabe
Carroll High School

ABSTRACT

Two different types of iron-cobalt alloys are being considered for use in the integrated power unit of the more electric aircraft. The Telcon material is manufactured in England, and the Carpenter material is produced in Pennsylvania. Both materials were studied in this experiment with the intent of determining the effects of heat treating on their dimensions. Unfortunately, the results of this experiment were inconclusive based on the failure of two sets of heaters and four thermocouples. Despite the difficulty in obtaining reliable data, the setup and procedure of the experiment worked well and could be used again if the experiment were to be finished at a later date.

The rack method, used to hold the thin samples upright so that they had a limited number of contact points with other metal, also worked well. The rack was made with a 90 degree angle to hold the samples. They were held in place by stainless steel wires on either side of them about one inch up from the base. Thermocouples were touching 6 of the 8 samples and were reinforced by stainless steel wires on the other side of the samples for support. The procedure would have been fine if the furnace was capable of reaching 800C while maintaining a vacuum. This was thought to be the case in this experiment, but after two heater failures it is now thought otherwise. One possible explanation for the failures is that at no time during the experiment were all four heaters working at once. This experiment should be carried out fully at a later date. Due to the constraints of time and equipment, the results remain as much in question now as they were before this experiment was begun.

A STUDY ON THE IMPACT OF VOLTAGE AND FREQUENCY LEVELS ON THE CONDUCTIVITIES AND EFFECTS OF POLYMER DISPERSED LIQUID CRYSTAL HOLOGRAMS

Rajeev Raghavan
Centerville High School

Abstract

In this investigation, samples of Transmission and Reflection holograms were prepared from Polymer Dispersed Liquid Crystal Syrups. These samples were exposed to varying levels of frequency at constant voltage, current, and temperature. The different voltage levels were analyzed to compare the conductivities and effects of the holographic samples.

TUNGSTEN ALLOYS: CORROSION POTENTIAL AND DESIRABILITY FOR USE IN MUNITIONS

Kristan Raymond
Walton High School

Abstract

Tungsten and tantalum alloys are being considered for use in kinetic energy penetrators and other munitions. Their high density and strength make them ideal candidates for these and other purposes. Tungsten alloys are being considered by Wright Laboratory. Therefore, this report concentrates on them rather than tantalum alloys. Currently depleted uranium is widely used in the penetrators, but the relative merits of tungsten alloys are being explored.

Recently, some tungsten alloys were found to readily corrode under humid conditions. Until now, the corrosion of tungsten alloy was not seen as a problem. Several studies have been done on the corrosion potential of tungsten alloys since this discovery. The purpose of my experiment is to gain even more information on the corrosion potential of these alloys and provide a basis for further testing.

I conducted immersion testing on tungsten alloys in solutions with pH's ranging from 2 to 12, stream water, gulf water, and 2.5% and 5% salinity. The solutions were sampled on Day 1 and 32. The alloys showed different amounts of tungsten and nickel. The amount of metal dissolved in solution varied with pH. With the data currently available, there does not seem to be a toxic level of any of the alloyed metals in the solutions.

Improvement of Automatic Data Processing Equipment
(ADPE) Accountability System

Adam Z. Reed
Tipp City High School

Abstract

Our goal was to create an accountable automatic data processing equipment (ADPE) system. This involved updating and comparing databases, doing physical inventories, and reporting the results to the appropriate people.

A STUDY OF THE VERTICAL SHIFTS IN SCENE PERCEPTION MEMORY

Esther I. Resendiz
W.H. Taft High School

Abstract

Two sets of scene photos, close-ups and wide angles, were analyzed for vertical shifts in the scene perception memory of the people who drew them. The original photos were those used by Intraub and Richardson (1989). In that study students examined each picture for 15 seconds and were told to redraw the pictures exactly as they remembered them. For my research, I identified common points between the originals and the drawings that the subjects had created. I then measured the vertical position of each point with respect to the middle of each picture. I did this for both the close-ups and the wide angles. I then compared each of the drawings to the originals. I found that, generally, the subjects contracted the objects in the pictures they drew and also had a greater tendency to shift objects in their scene perception memory downwards rather than upwards.

DEVELOPMENT AND TESTING OF AN OPTICAL SCAN CHARACTERIZER

Franklin K. Reyher III
WL/MNGS
Wright Laboratories
Eglin Air Force Base, FL

Abstract

Scanner-driven LAser Detection And Ranging (LADAR) systems may return inaccurate data when their scanners are driven at extremely high speeds. It is desirable to determine which portions of a LADAR scan are nonlinear and may return inaccurate data. An optical scan characterizer was produced using an HP54510A Digitizing Oscilloscope, a Photodiode Detector Array (PDA) designed specifically for this application, and a continuous wavelength Helium Neon laser. These instruments were controlled via LabVIEW on a personal computer through GPIB and parallel interfaces. The scan characterizer was tested in the laboratory environment and determined the areas of the scan where non-uniform spacing of pixels exceeds tolerable limits.

A STUDY OF WEAR
USING A CAMERON-PLINT TRIBOMETER

Brian Riestenberg
Centerville High School

Abstract

A Cameron-Plint tribometer records data on wear, produced by rubbing a small cylinder across the surface of a disc, in the presence of a lubricating fluid. As the test is running a surface film is produced between the cylinder and the disc. After a test is finished, the cylinder, disc, and fluid are examined. The cylinder and disc show signs of wear that can be measured, and the fluid contains wear debris that can be studied to help determine what kind of film was produced in the process of the experiment.

NEURAL NETWORKS AND DIGITAL IMAGE PROCESSING

Douglas M. Ritchie

Abstract

The focus of investigation was broad, including Sensor modeling software, interpretation and evaluation of IMSS (Infrared Multi-Spectral Sensor), and investigation and evaluation of PCNN (Pulse-Coupled Neural Networks). This was accomplished with the help of Chris Clark, a first-year member of the High School Apprenticeship Program. The summer was divided almost evenly into these three categories and the task concerning each was primarily to gather information. The NeuroSeek Sensor Model, developed initially into Excel, had to be converted to MatLab in order to use multiple processing elements. Next, IMSS data, provided by Pacific Advanced Technology, was examined to determine whether or not the sensor provided enough data to accurately classify a simulated minefield. Finally, code implementing Pulse-Coupled Neural Networks was analyzed and the parameters of the network were tested.

A STUDY OF THE DEICING OF AIRCRAFT

Alejandro F. Ruiz
South San Antonio High School

Abstract

The harmful effects of ice and snow collecting on the exterior of aircraft was studied. When the weather conditions contain ice, snow, and rain, aircraft that are parked outside can contribute ice on them. By deicing, the aircraft can fly safely.

A STUDY OF DE-ICING FLUIDS, METHODS, AND EFFECTS AS USED ON MILITARY AIRCRAFT

Marc A. Salazar

Judson High School

Abstract

Military de-icing fluids, their types and effects on aircraft and environment, were studied. There are four types of military de-icing fluids, all of which were studied. As a preflight team deices a potentially harmful aircraft using these fluids, the runoff enters stormwater drainage systems and ground water around the airfield. Eventually these fluids will make way to nearby rivers, lakes, streams, ect. The fluids reduce the amount of oxygen in the water for microorganisms to live. De-icing and proper de-icing methods are essential for a clean aircraft thus ensuring a safe flight. By testing for the Biochemical Oxygen Demand and Chemical Oxygen Demand caused by these fluids, the perfect combination of a less polluted water system and a flight safe aircraft can be obtained.

ELECTROMAGNETIC FIELDS IN A SINGLE SLAB FOR OBLIQUE INCIDENCE

Jonathan Samn
Theodore Roosevelt High School

Abstract

A program was created and tested to calculate and plot points for electromagnetic field attributes in a single dielectric slab. The points were changed by modifying the frequency of the incoming field, the angle of incidence at which the field was coming in, and type of polarization, either transverse electric(TE) or transverse magnetic(TM) polarizations. These, in turn, were graphed so that the behavior of the electromagnetic field within an air-water-air media would be further understood. This program is just a basis program and will be preassigned properties of water and air, such as permittivity. Such a program would, in the near future, be used and modified to handle any number of slabs of any composition. Thus it would be useful for gathering information on the effects of electromagnetic propagation through the human body with its many epidermal and muscular tissue layers.

The Use of Reverberation Chambers for Susceptibility Testing on Airplane Electronics

Seth B. Schuyler
Sandia Preparatory School

Abstract

New and more efficient means of gathering important electromagnetic susceptibility data have been found. The system has been automated to increase efficiency. Now it is easier to find the electromagnetic frequencies that will cause a piece of electronics to malfunction. This will allow smaller industries to test for susceptibility creating a more electromagnetic compatible world.

ANALYSIS OF POLY-ALPHA OLEPHIN BY GAS CHROMATOGRAPHY

Keith A. Shaw
MacArthur High School

Abstract

A gas chromatographic method was attempted to analyze and successfully quantitate the heat exchanger Poly-alpha olephin (PAO). Methods of sample injection included a Dynatherm ACEM 900 sample tube collection, a porous glass diffusion chamber, and air sample output from an On-Board Oxygen Generating System (OBOGS). The results were sometimes erratic and generally inconsistent due to difficulty in desorbing the PAO from an adsorption tube. Experimental results indicate that gas chromatography would not be a satisfactory method for analyzing PAO in the gas phase in low (ppm) concentrations.

A STUDY OF ALPHA FACTOR IN SEMICONDUCTOR LASERS

William D. Shuster
Albuquerque Academy High School

Abstract

The characterization of semiconductor diode lasers is an important event that must happen in order to get a efficient laser. A laser properly characterized gives off a beam that is even and energy efficient. If semiconductor lasers are to be used they must output a beam that is coherent are gives off enough energy for practical uses. This can be accomplished through characterization.

A Study of Improving the Computed Air Release Point using Neural Networks

Trisha A. Silkauskas
WL/FIVMB
Special Projects Section
Centerville High School

Abstract

The Computed Air Release Point (CARP) using neural networks was studied. When the neural net assumed the expected output would be zero, the output was near zero. Upon closer examination, it was decided that an expected output of zero might not adequately test the neural network. Unfortunately, by virtue of the fact that the expected output of the training data was random in nature, the output of the test data had no predictable expected values to compare it to. This does not mean that the neural network did not work. It means that more airdrop data needs to be collected before the value of a neural network for determining CARP can be accessed.

FABRICATION OF A WIDE SPECTRUM IMPULSE RADIATING ANTENNA

Raj C. Singaraju
Albuquerque Academy

Abstract

This paper discusses the construction of a wide spectrum reflector antenna with an emphasis on transmission line design and construction, coax design and construction, and resistive termination of the transmission lines. The antenna created is an Impulse Radiating Antenna with a diameter of 45.7 cm and an F/D of .5. It is fed by two flat transmission lines which emerge from the side of the antenna and are connected in parallel at the focal point. The goal of this project is to create a fast rising, slow decaying voltage wave pulse, with an amplitude of 30 kV at the pulses apex. A pulse of this type creates a wide spectrum radiated field extending from roughly 500 MHz to 5 GHz.

TURBINE ENGINE MODEL LIBRARY

Daniel Sipe
Coffee Co. Central High School

Abstract

A turbine engine model library was created for easy access to turbine engine computer models. A DOS directory structure was used to organize the models which permits several levels of categorization and enables expansion to accommodate additional models. Hypertext Markup Language was used to design a user interface for accessing the contents of the Library. Twenty-three engine models were retrieved from various computers and are included in the turbine engine model library. The result is an Internet type page which provides access to the library via the internal web at Arnold Engineering Development Center.

SUMMER SCIENCE PROJECTS

Michael J. Steiger
Oakwood High School

Abstract

Throughout the summer several projects have been completed; including temperature dependent transmission studies of conductive polymers and creating a resource database. The conductive polymer transmittance study as a function of temperature was performed to try and see shifts in the band edge of the spectra. The temperatures ranged from -160° C to 200° C. Shifts in the band edge were not seen although a couple of problems came about in the experiment. The two problems were baking off part of the polymer at the high temperatures and the other was frost building up on the windows of the vacuum container, Specac®. The resource database was created to organize electroluminescent articles and make access to those articles an easier process.

A STUDY OF THE EFFECTS OF OCTANOIC ACID ON POLYMER DISPERSED LIQUID CRYSTAL HOLOGRAPHIC GRATINGS WITH VARYING PERCENTS OF LIQUID CRYSTAL

Kari D. Sutherland
Dayton Christian High School

Abstract

The focus of this experiment was to study the effects of the surfactant octanoic acid on polymer dispersed liquid crystal gratings using varying percents of liquid crystal. The different percents of liquid crystal used in the syrups were 30%, 50%, 70% and 79% E7. Samples were constructed of each syrup and exposed for seven minutes to an Argon Ion laser with a wavelength of 514 nm. After exposing, an experiment was set up using a helium neon laser at 633 nm to measure the diffraction efficiency of each sample at s and p polarization. Switching voltage was done to select samples. The best sample from each E7 percent sample was observed under the Polarized Optical Microscope (POM), and pictures were taken. The samples were then peeled and sent to the Scanning Electrical Microscope (SEM) to look further into the samples. The 30% sample showed good improvements in the diffraction efficiency and voltage switching when the octanoic acid was added. The 50% also showed improvement with the surfactant, although more experimentation could be done to improve the results. The 70% and 79% samples showed no real improvement with the surfactant.

HYPERTEXT MARKUP LANGUAGE: CAUGHT IN THE WEB

Patricia M. Swanson

Abstract

HyperText Markup Language, or HTML, is the computer language of the World Wide Web. The World Wide Web, also known as WWW or W3, was first proposed in 1989 and has grown rapidly in its short time of existence. It has become a significant aspect in the lives of many, and in turn HTML has become more important. Both play a role in the information exchange that exists across the thousands of computers encompassed by the Internet throughout the world. Since it is so widely used by people in all different parts of the world, of all different races, religions, and cultures, with unique purposes, it is made to be easily understood and adaptable.

A METHODOLOGY FOR ASSESSING THE PERFORMANCE OF THE J-4 ROCKET TEST FACILITY

Daniel M. Thompson
Shelbyville Central High School

Abstract

The primary objective of the project was to define a method to investigate the J-4 rocket test facility performance boundaries which determine the run-time and altitude simulation. The capability of the system to test successfully depends on the required consumables of steam, cooling water, and propellant which exist in limited supply. A spreadsheet was developed to estimate run-time duration as a function of engine thrust. Assumptions were made with regard to basic conditions. Characteristic results were produced displaying trends of facility performance as a function of engine thrust.

BAND GAP PROPERTIES OF InAS/$In_xGa_{1-x}Sb$
AS A FUNCTION OF GROWTH-INDUCED DISORDER

Jeroen W. Thompson
Beavercreek High School

Abstract

InAs/$In_xGa_{1-x}Sb$ is a useful material for far-IR detectors. While much theoretical work has been done for hypothetical perfect-growth lattices, the growth conditions for InAs/$In_xGa_{1-x}Sb$ cannot be perfectly controlled. In particular, there is evidence to suggest the bandgap for InAs/$In_xGa_{1-x}Sb$ undergoes a drastic decrease under random-growth conditions. (100)-grown InAs/$In_xGa_{1-x}Sb$ is investigated through a Monte Carlo simulation. Our transfer-matrix model calculates a number of possible transitions between the valence and conduction bands of a superlattice with random variations in layer widths, in effect approximating the joint density of states for the superlattice. The joint density is used to propose an effective band gap for disordered InAs/$In_xGa_{1-x}Sb$.

INTERIM QUALIFICATION TESTING OF TUNG 5 MOD 6

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Abstract

Tung 5 Mod 6 was studied; in particular, its sensitivity characteristics were determined using certain standardized tests such as the Henkin time-to-explosion test, the Impact Sensitivity test or Drop Hammer test, the Friction Sensitivity test, the Accelerating Rate Calorimeter (ARC) test, the Large Scale Gap Test (LSGT), and the Electrostatic Discharge (ESD) test. These qualitative tests showed the sensitivity of Tung 5 Mod 6 to heat, friction, impact, electrostatic discharge.

A Study of the Computer Networking Environment

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Abstract

The problems and intricacies of a computer network were studied. In order to study these problems a computer to be used as a print sever, World-Wide-Web or WWW server, and a remote dial-in server was set up. The setup of this computer included installation of Linux and all other applications which would serve to make the computer an integral part of the network. Most problems encountered along the way which required in-depth attention involved integration between UNIX and Macintosh hardware.

A CELL STRUCTURED PLANE SYSTEM FOR MONTE CARLO PHOTON TRANSPORT

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Abstract

Tracing the probabilistic path of a photon requires a coordinate system that allows detailing of the position and motion of the particle. Several possibilities for such a system exist, however a cell structure offers a convenient and orderly approach for studying the interactions the photon may experience such as absorption and scattering. The process of building such a cell system is presented here. The source code has been written in Fortran 77 on a Silicon Graphics workstation to be used for the transfer code written originally by Dr. Michael Egan and Dr. Russell Shipman at Phillips Lab Geophysics Directorate, Hanscom AFB, Massachusetts.

COMPREHENSIVE TESTING FOR THE SELECTION OF AIR FORCE CREW MEMBERS

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Abstract

The selection of acceptable air force personnel has long been a key element to the overall quality of the accomplishements of the Air Force. This process, however has undertaken au fond constant reconstruction ever since its arrival to the system. The reconstruction currently at hand focuses on the generalization of specific data fields, and their incorporation into the "prediction" of crew performance in those fields. The problem with the specifics of this sort of testing, however, has long been a factor in unreliable test results, and thus, is the focus of the research which is here described. In an effort to supply more general knowledge testing ideals, a series of specific, yet moderately difficult tests has been supplemented, and therefore combined into a single test. This new comprehensive approach to knowledge-testing is the basis of the selection of air force personnel currently under construction. It is with these efforts that the air force can expect to fulfill its accomplishements, and ultimately, itself through the personnel with which it is contrived.

The Effect of Hyperbaric Oxygenation on Du-145 Cells

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Abstract

The effects of hyperbaric oxygenation on Du-145 cells was studied with and without the use of chemotheraputic drug solutions. Du-145 cells were collected then exposed to conditions equivalent to 45 feet below sea level using a hyperbaric chamber or left at sea level as a control. Some of the cells were dosed with solutions of Taxol, Adriamycin, or Cisplatin. The experimental data indicated that hyperbaric oxygenation increased the effects of the Adriamycin on the cancer cells while it showed little effects when used in conjunction with the other two drug solutions.

Hydrocode Support Development

Joshua A. Weaver
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Abstract

While projectile design and experimentation are critical to the Air Force's development, limitations require the most economical use of scarce resources. For this reason, much of the actual research and development of modern munitions is conducted through computer simulations, saving the cost of building and physically testing new designs. Unfortunately, many of these tools interact with their users through primitive interfaces, relics from the entirely text-based days of computer operating systems. While these programs are still fully functional and beneficial, a more sophisticated interface would maximize productivity while eliminating many of the common user errors through automation.

Graphical User Interfaces (GUIs) were developed in Visual Basic for two programs in common use in Computational Mechanics section of WL/MNMW. Moments is a simple utility program that calculates standard information for axisymmetric projectiles. The EPIC hydrocde dynamically simulates projectile impact scenarios and is the most heavily used program in Computational Mechanics.

SWIPE METHOD DEVELOPMENT FOR THE TRACE ANALYSIS OF UNICHARGE (M231 and M232) COMPONENTS IN COTTON GAUZE EXTRACTS USING HIGH-PERFORMANCE LIQUID CHROMATOGRAPHY (HPLC) WITH AN ULTRAVIOLET DETECTOR (UV)

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Abstract

Methods were developed to collect the trace compounds from the unicharge (M231 and M232) outer shell casings and for the analysis of those compounds with the use of high-performance liquid chromatography. The trace compounds include nitroglycerin, nitroguanidine, dibutylphthalate, diphenylamine, 4-aminobiphenyl, 2,3-dinitrotoluene, 2,4-dinitrotoluene, 2,6-dinitrotoluene, and 3,4-dinitrotoluene. These methods were developed for stored unicharge shells where the samples would have to be transferred back to the laboratory for analysis. Swiping the outer shell casings provided the surface concentration of the trace compounds for a dermal hazard assessment of the unicharge. Sample analyses indicate that there is a hazardous amount of the trace elements on the surface of each unicharge casing. However, the rate of dermal penetration into human skin has not yet been determined.

Assessment of Hydrazine Monopropellant Plume Conductivity

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Abstract

The goal of the work reported here was to extend plume conductivity prediction techniques to monopropellant plumes and to assess the potential for charged particles in the plume for such a thruster. In an attempt to determine potential for charged particles, various aspects of hydrazine thrusters were researched, including rocket thruster basics, hydrazine decomposition chemistry, and hydrazine contamination. Through these studies, it was found that hydrazine has various sources of contamination that could possibly increase the conductivity of the plume. Additional confirmation of the contamination levels was found through an independent analysis of hydrazine fuel for alkali contaminants, especially for sodium, potassium, calcium, and magnesium because of their low ionization potentials. Sodium was found to be the most abundant alkali metal, and therefore chosen to be the test contaminant. Next, a theoretical model of a hydrazine thruster, based on the NASA SP273 computer program, was used to calculate rocket performance and reaction products for a typical hydrazine thruster. These data were then compared to actual performance data and found to be within 20% of real rocket performance data. With the addition of sodium contamination at 200 ppm, the model was run again to find mole fractions of electrons existing in the nozzle. Through these predictions, it was shown that the electron number density was too low for a significantly charged plume.

PRE AND POST MICROSTRUCTURE DAMAGE ANALYSIS OF TUNG 5 MOD 6

Tuan P. Yang

Abstract

The goal of this investigation was to document explosives of pre and post test procedures using density tests and microstructural analysis. As specified in the title, Tung 5 Mod 6 was the explosive of choice to be studied. However, another explosive, PBXN-109 was also incorporated into the polishing and density tests. These samples were sectioned off and analyzed. Documentations were made in polishing, density measurements and microscope analysis. These procedures contributed to the overall identification of the extent of microstructure damages in each specimen.

The first step taken in this procedure was to section the samples into workable pieces. The sample preparation involved designing a device to hold the explosives while they were being polished and coding the samples to know the exact location from which they were extracted.

Polishing was the next step in the procedure. It was done in the presence of water to minimize frictional heating. The polishing medium used was sandpaper that varied from an initial 320 grit to a final 8000 grit. The latter grit was used for a more polished texture than the smaller grits. The purpose in polishing the explosive was to remove any damages caused during cutting operations.

Pictures were taken of the samples before and after they were polished. Equipment used was a stereomicroscope equipped with a 35mm camera and a scanning electron microscope (SEM). These pictures helped in validating the topography of the explosives before and after polishing.

CEREBRAL OXYGEN LEVELS AS A PSYCHOPHYSIOLOGICAL MEASURE OF PILOT WORKLOAD

Eric Yu

Abstract

Cerebral oxygen levels were monitored during simulated tracking tasks in a full F-16 fighter cockpit mockup. The tracking task became increasingly difficult for each of three data collection runs to induce a physiological response in cerebral tissue oxygen saturation. Pre- and post-baseline data was gathered with subjects' eyes open or closed, alternated between runs. Correlation was established between flight activity and cerebral oxygen levels but could not be reliably confirmed. Pre- and post-baseline data had no significant difference between having subjects' eyes open or closed.

DETERMINING THE STATIC VOLTAGE DISTRIBUTION ON CIRCUIT STRUCTURES

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Abstract

The static voltage distribution on circuit geometries was studied. The static voltage distribution in the vicinity of conducting structures is described by Laplace's equation. Numerous techniques are available for solving Laplace's equation. For this work, an iterative averaging scheme was chosen. Numerical simulation issues of accuracy, grid resolution and boundary conditions were investigated.

Analysis of Human Muscle Movement Under Increased Acceleration

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Abstract

Analysis of experimental data was conducted to better understand human movements in an increased gravitational environment. Thirteen subjects were asked to perform a sequence of rising from a chair, and jumping movements at increased G levels. The subjects completed these movements on three separate days at each of the following G levels: 1.0, 1.2, 1.4, 1.6, 1.8, 1.6, 1.4, 1.2, 1.0. Subject data was collected using electromyographic electrodes, 2 force plates (1 ground, and 1 seat), video camera, and protective balance bar. The force applied to the bar (strain gauge), and force plates were recorded for later analyses. Four leg muscles (gastrocnemius, vastus lateralis, semitendinous, and gluteus maximus) were monitored and recorded during their movements. Initial analysis indicates subjects were able to perform all of the movements at all of the G levels. There is also an indication that a training effect is taking place.